

The Effect of Colour on Consumer Purchase Behaviour

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To my parents and husband.

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In completing this long journey, I am grateful to many people.

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ABSTRACT

We live in a world of product overproduction. Companies manufacture products that they cannot sell and this causes environmental problems, wastes energy and water, and reduces the efficiency of the companies. It is known that the colour of products and their packaging can affect consumer response. Inappropriate select of colours by manufacturers and retailers is thought to be a major contributing factor in product overproduction. Colour theory and human response to colour has great potential to help to understand the role of colour in product packaging. However, it is not clear whether colour perception and preference have been effectively utilised in design. A limited understanding of colour strategy in product-colour design calls attention to the need for studies about colour information (individual colour preference and colour association, in this research).

The aim of this research is to investigate the effect of colour on consumer purchase behaviour (specifically product packaging colour) and the role that this may play in product colour design. A potential impact of this research is that products will be designed in colours that lead to less overproduction. The research adopts a framework (with three studies and a meta-analysis, six research activities and three research methods) to understand the relationship between consumers' product-colour purchase intentions, their colour preferences and their response to colours.

The main finding is that consumer individual colour preferences influence consumer product-purchase intentions but are more likely to do so in the absence of primary colour factors such as colour functionality, colour performance and colour associations. This framework potentially allows a prediction about which product categories individual colour preferences are most important for. The framework also supports the idea that consumers might make different product-colour decisions when they are in different decision conditions. Specifically, the work explores the effect of the amount of time available for a purchase decision and finds some evidence that individual colour preferences may be more likely to influence consumers' product-colour purchase intentions in a short-time decision-making condition and vice versa.

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CHAPTER ONE – INTRODUCTION

‘What do we mean by colour trends and what are the main influences on colour trends? How do colour trends interact with our daily consumption or conservation of design, products and materials? What is the relationship between design, material and colour trends and how important are colour trends in design? How important is colour forecasting to designers?’

- Hidefi (2017)

1.1 Research background

Our environment is constantly changing. There is no denying that people need to become increasingly aware of the problems that may affect or threaten the environment (WHO, 2015). There are increasing numbers of natural disasters, warming and cooling periods, different types of extreme weather patterns etc. There are 15 major current environmental problems of which people need to be aware: Pollution, Global Warming, Overpopulation, Natural Resource Depletion, Waste Disposal, Climate Change, Loss of Biodiversity, Deforestation, Ocean Acidification, Ozone Layer Depletion, Acid Rain, Water Pollution, Urban Sprawl, Public Health Issues and Genetic Engineering (WHO, 2015). However, product overproduction contributes to environmental problems such as Pollution, Natural Resource Depletion, or even Waste Disposal. Burberry’s own annual report revealed that £28.6 million worth of stock was destroyed in 2017 alone; it is estimated that over the past five years more than £90 million of unsold product has been destroyed by Burberry (BBC, 2017). Overproduction is thought to cause environmental problems (air pollution, groundwater pollution etc.), energy waste (electric energy etc.) and natural resource waste (groundwater etc.). In other words, reducing product overproduction is an important aspect of product design.

Product overproduction. Overproduction is making products in too great a quantity (or faster) than can be consumed at the time, which also causes other inefficiencies

(transportation etc.) and environmental problems (air pollution etc.). ‘Overproduction is the most serious of the seven waste of lean manufacturing (seven Mudas)’ (Jacobson, 2017). Further examples include: cars (Auto) that remain unsold in a car dealer lot; luxury goods maker (Burberry) destroyed (burned) unsold clothes (BBC, 2017) etc. One of the approaches that have been proposed is ‘CPFR’, which includes collaborative planning, forecasting and replenishment (Sharma *et al.*, 2013). It suggests to develop single forecasting into one process, in which each of the processes is owned by the manufacturer, the retailer, managed jointly or even by the designer. In this case, ‘Work to forecast’ has been suggested (Handa and Abdalla, 1989). The forecasting combines information from consumers (including consumer market actions, choices, etc.). Moreover, it forecasts efficiently the consumer demand which are the levels of consumption (corresponds to the level of production). In other words, if effective demand is achieved then there is no overproduction because all inventories are sold (also to reduce out-of-stocks delivery times and the waste of various resources) (Chen *et al.*, 2019). This raises the question of how manufacturers could better understand consumer demand; what data about consumers is available and how could it be used to reduce overproduction?

The colour of products and/or their packaging is important and can affect consumer purchase behaviour. Two important concepts that relate to this are discussed:

- *Product (packaging) colour in marketing.* ‘Where the eye stops, the sales begin’ (Pieters *et al.*, 2010). The attention of consumers is captured through the use of visual elements (Grossman and Wisenblit, 1999). Consumers make purchase decisions based on visual examination of packages (Clement, 2007). This places enormous importance on packaging as a powerful visual element (Aslam, 2006; Kauppinen-Räsänen, 2014). Moreover, colour has been recognised as one of the most powerful visual elements in packaging (Kauppinen-Räsänen, 2011). Packaging colour invokes a person’s imagination of the product within (Orth *et al.*, 2010). Thus, choosing an appropriate colour for a packaging or a product is

significant and may affect consumer decision-making. More details are introduced in section 2.2, CHAPTER 2.

- *Colour theory and product colour.* An underlying understanding of colour theory is very important to ensure that products (and/or their packaging) is produced in appropriate colours that are attractive and generate an appropriate (and strong) emotional reaction which may boost sales or reduce product overproduction (Kauppinen-Räsänen, 2014, Schnurr *et al.*, 2017). Colour theory has great potential to help understand the role of colour in product packaging, and to use colour scientifically in product design. However, colour is an interdisciplinary discipline that includes science, design, art, history etc. It is not clear whether colour information has been effectively utilised in design. More details are introduced and discussed in section 2.3 and 2.4, CHAPTER 2.

1.2 Research Aims

One of the *challenges* frequently encountered by designers is the disappointment of a colour selection that generates undesired results. Occasionally, colours fail to induce the intended emotions (or convey the intended information). The multifarious nature and multiple functions of product colour or packaging colour are highlighted in CHAPTER 2. The work in this thesis is underpinned by an appreciation that better colour design could result if there was better understanding of individual colour preference and its relationship to product colour preference and colour association. Currently, consumer individual colour preferences may be important in consumer purchase decisions, but the exact nature of their role is less than clear (Westland and Shin, 2015). Also, Palmer and Schloss (2010) suggested that colour preferences are due to an effective response to colour-associated objects. This suggests that the associations

(or meanings) that product colours have may drive consumer purchase decisions (in CHAPTER 2).

The research addressed in this dissertation is motivated by a lack of studies on *individual colour preference* and *colour association* in product colour (or packaging colour). Therefore, the overall aim of this research is to investigate the effect of colour on consumer purchase behaviour (specifically on product packaging design), which may help designers to better select successful product colours. It is hoped that the limited understanding of individual colour preference and colour association in product packaging colour design (or selection) will be improved through this study.

The overall aim for the thesis can be expressed in terms of three objectives which relate to product-colour research (details are discussed in Section 2.5, CHAPTER 2; section 3.1, CHAPTER 3):

1. To *explore* the extent to which personal individual colour preference and personal colour association affects consumers' product-colour choices, and to *explain* why it happens;
2. To *explore* whether the length of shopping time affects consumers' product-colour choice and to *predict* what is likely to happen in different situations;
3. To *explore* and *understand* the relationships between colour preference, colour association, the decision conditions (referred to as time-length in this research) and other factors when consumers purchase a product of a particular colour.

1.3 Research Design

Based on these objectives, nineteen research questions have been identified (see Section 2.5, CHAPTER 2). An *abductive* research strategy has been primarily chosen for the

research. Deductive and inductive strategies have also been employed specifically to test or build theories for several of the sub-research questions (CHAPTER 3). This research focuses on the areas listed below:

Product-packaging and product colour in consumer purchase behaviour (CHAPTER 2): It is critical to understand how product packaging drives product decision making.

Colour theory in product colour research (CHAPTER 2 and 3): It is critical to understand which aspect of colour theory could help to explore the role of product colour in consumers' product colour purchase intentions.

The effect of colour preference and colour association in product colour on consumer purchase behaviour (CHAPTER 4 and 5): To understand the role of colour in consumers' product-colour purchase decisions in the context of *individual colour preference* and *colour association*.

The effect of decision condition in colour factors (CHAPTER 6): It is critical to explore how colour factors influence consumers' product colour choice in different decision conditions (the colour factors are introduced in CHAPTER 4, 5 and 6).

1.4 Thesis structure

This thesis is organised into eight chapters which are briefly summarised below:

- **CHAPTER 1 - INTRODUCTION**

Chapter one provides a brief overview of the research background and motivation, aims and objectives, scope, and overview of the thesis structure.

- **CHAPTER 2 - LITERATURE ANALYSIS AND SYNTHESIS**

Chapter two provides a review of the research area through analysis and synthesis of relevant literature in three fields of consumer behaviour and colour. Based on this

review, ‘product-colour’, ‘colour theory’ and ‘colour perception and preference’ for consumer behaviour have been identified and highlighted.

● **CHAPTER 3 - RESEARCH DESIGN**

Chapter three lays out the research methodology and research strategy based on a critical review; adopts a research strategy and a framework (see FIGURE 3.3.3); outlines a set of research methods (see TABLE 3.4.3) and research activities (see TABLE 3.4.2) and a series of studies plan (see Table 3.5) for this research.

● **CHAPTER 4 - STUDY I: THE ROLE OF COLOUR PREFERENCE ON CONSUMERS’ PURCHASING BEHAVIOUR**

Chapter four establishes a framework for how individual colour preferences affect consumer’s product-colour decisions (see FIGURE 4.2.2). An online survey and a laboratory experiment are described and generate new data about the role of colour preference in product and product packaging on intended consumer purchase decisions.

● **CHAPTER 5 - STUDY II: THE ROLE OF COLOUR ASSOCIATION ON CONSUMERS’ PURCHASEING BEHAVIOUR**

Chapter five updates the framework (second framework) from the previous chapter to include the role of colour association on consumers' purchasing behaviour (see FIGURE 5. 2.2). Face-to-face interviews and a laboratory experiment are described and generate new data about colour preference and colour association.

● **CHAPTER 6 - STUDY III: THE EFFECT OF DECISION TIME-LENGTH CONDITION ON CONSUMER PRODUCT-COLOUR PURCHASE DECISOIN**

Chapter six further updates the framework (third framework) to include the effect of decision time-length on consumers' purchasing behaviour (see FIGURE 6.2.2). In this chapter two sets of online surveys and two laboratory experiments are described (short-time and long-time product-colour decision-making conditions).

● **CHAPTER 7 - FURTHER ANALYSIS OF COLOUR PREFERENCE DATA**

Chapter seven further analyses experiment data from the previous students (Studies I,

II and III) to generate new insights into the relative effectiveness of different methods and the effect of gender and nationality.

● CHAPTER 8 – CONCLUSION AND DISCUSSION

Chapter eight discusses and summaries the key findings from the thesis, reviews the research contributions and limitations, and suggests further work.

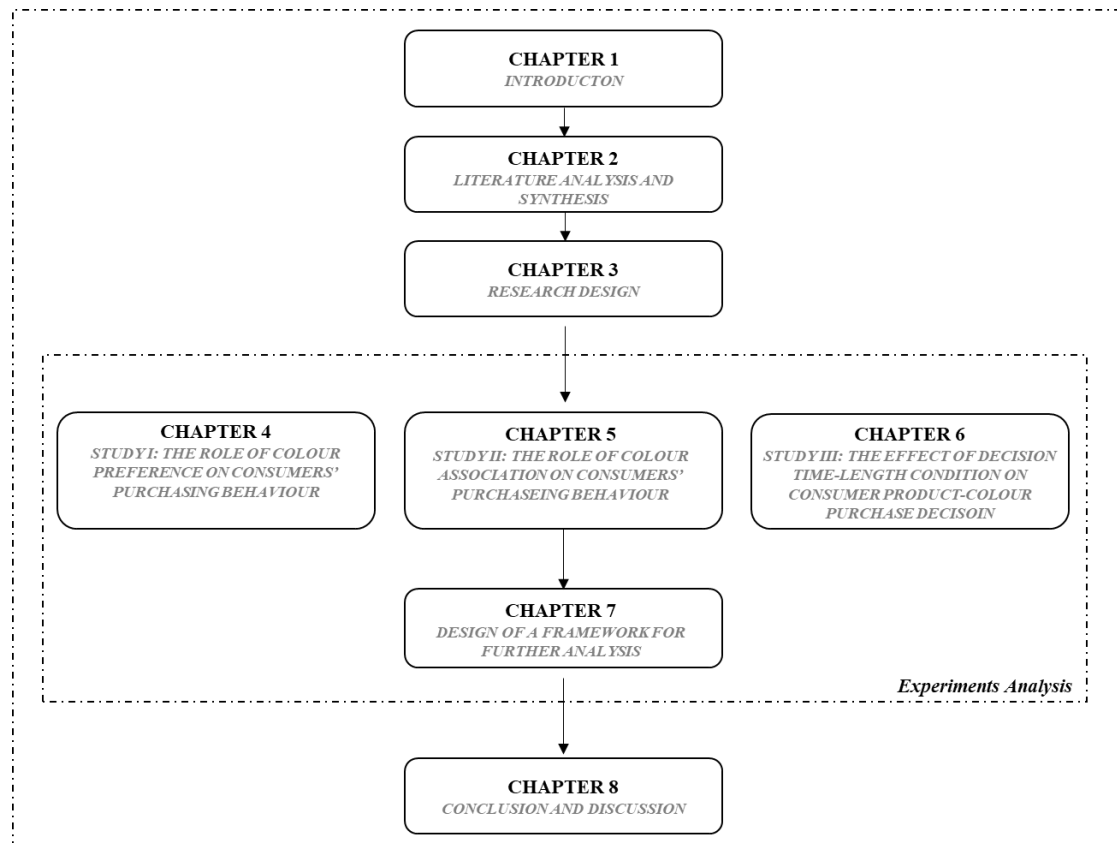


FIGURE 1.3 Thesis structure.

2 CHAPTER TWO – LITERATURE ANALYSIS AND SYNTHESIS

‘What is colour? Turning to dictionaries to answer this question, the reader finds that in general colour is defined by negatives: ‘the visual property of light which is not related to lightness, saturation, texture, glossiness or translucency’. It is the primary sense in distinguishing ripe from unripe fruit and safe from unsafe meat; it informs us of the quality of beer or honey.’

-Best (2017)

2.1 Introduction

CHAPTER 1 suggested that product packaging acts as the ‘silent salesman’ in-store or online to attract consumers at the point of purchase (Inman *et al.*, 2009; Kauppinen-Räsänen, 2014). It is not surprising, therefore, that product packaging often serves multiple functions, from functional to promotional, and has a focal role in consumers’ product decision-making (Madzharov and Block, 2010; Silayoi and Speece, 2007). Given the importance of product packaging, it is critical to understand *how* it drives product decision making (Deng and Kahn, 2009). Clearly, colour has been suggested as one of the most powerful visual elements in packaging that can potentially reach consumers at a deeper affective level at the first impression and beyond (Kauppinen-Räsänen, 2011).

For many decades, there has been strong focus on providing consumers with the right colour for the right product at the right time (Best, 2017). In many industries colour trend forecasting has emerged as an important process which, it is claimed, can benefit both manufacturers and retailers and may also lead to reduced waste and reduced environmental impact (Cassidy, 2019; Diane and Cassidy, 2009). However, in many situations (whether colour trend forecasting is dominant or not) it is strongly suspected that the colours chosen by designers for a particular product are not optimal (Best, 2017;

Won and Westland, 2017).

In this chapter, the fundamental concepts and definitions that related to this thesis are reviewed and the significance and potential advantages of colour elements in product colour (or product packaging) are highlighted and analysed. A critical overview of consumer behaviour, product colour and colour theories are carried out and gaps in the existing literature and understanding for product colour are identified. Through the synthesis of relevant literature in these fields, the initial framework for the research is designed and refined.

Chapter 2 consists of five sections. Section 2.1 provides a brief introduction to this chapter. Section 2.2 discusses why it is important to study colour in the context of consumer product purchase behaviour and elucidates the key role of colour in product packaging. Section 2.3 reviews some basic ideas in colour theory. Section 2.4 analyses colour perception and preference, including colour preference and colour association, reviews the research methods and results for colour preference and addresses the relationship between colour association and colour preference which will be used in this study. Section 2.5 summaries this chapter and synthesises the initial framework.

2.1 Introduction					
2.2 Consumer Product- Colour Variety	2.2.1 Product packaging is a crucial element in consumer behaviour	2.2.2 The meaning of colour in product packaging	2.2.3 The application of colour in the design of product packaging	2.2.4 Summary for product colour	
2.3 Colour Theory	2.3.1 Colour ontology	2.3.2 A history of colour theory in Art, Science & Design	2.3.3 Colour description and communication	2.3.4 Colour information	2.3.5 Summary for colour theory
2.4 Understand colour perception and preference	2.4.1 Experimental method for colour preference research	2.4.2 General individual colour preference	2.4.3 Theoretical explanations and influential factors	2.4.4 Colour association	2.4.5 Summary for perception and preference
2.5 Discussion for CHAPTER 2					

FIGURE 2.1 Structure for CHAPTER 2.

2.2 The Role of Product Colour

The last few decades have seen an increasingly sophisticated use of colour by marketing

and brand experts (Labrecque *et al.*, 2013); for example, brands such as Apple, Dell, and GE now frequently display a wide array of colour choices for laptops, mobile phones, and even toasters and refrigerators when not long ago these products were grey, black or beige (Buether, 2014). Yet despite the pivotal role of colour in consumers' daily lives, relatively little marketing research has been carried out in this area (Labrecque *et al.*, 2012). Many practitioners confess to a lack of knowledge upon which to base their colour decisions (Gorn *et al.*, 1997; Grossman and Wisenblit, 1999). A major review highlighted the lack of colour research in the context of marketing and consumer behaviour and urged researcher to undertake new studies (Labrecque *et al.*, 2013).

2.2.1 Product packaging as a critical element in consumer purchase behaviour

One of the first and most immediate ways of capturing consumers' attention (and influencing their purchase decisions) is through the use of visual elements, especially packaging (Grossman and Wisenblit, 1999). According to one study, up to 90% of consumers make their purchase decisions based on visual examination of the packages (Clement, 2007) though, of course, this may be more or less true depending upon the product category. Nevertheless, this places enormous importance on packaging as a powerful visual element (Aslam, 2006; Kauppinen-Räsänen, 2014). Moreover, colour has been suggested as one of the most powerful visual elements of packaging (Kauppinen-Räsänen, 2011). Packaging colour may invoke a person's imagination of a product (Odbert *et al.*, 1942) and also may affect consumers' quality perceptions (Greene *et al.*, 1989). For example, in one study consumers were found to perceive darker products to be more durable and lighter products to be more convenient (Lunardo and Livat, 2016). It has been suggested that the darker products are perceived to be more durable because consumers infer that darker products are heavier than lighter products (Das and Hagtvedt, 2016). However, Orth *et al.* (2010) claimed that, despite their importance, visual elements (such as product colour) are a neglected topic in

scholarly research (Deng and Kahn, 2009).

As mentioned, despite growing marketing research interest in visual elements, studies about colour and its use in product packaging are limited (Kauppinen-Räsänen, 2011; Labrecque and Milne, 2012). Current research into this aspect of colour is still largely anecdotal, leading to colour selections in practice that may be based on trial and error or gut feelings (Labrecque and Milne, 2012). Theory plays such a limited role in this area that many practitioners believe that the use of intuition is the only (or best) way to solve the problem. In other words, an extensive theory of colour and marketing (product colour or product packaging) has yet to be developed (Grossman and Wisenblit, 1999; Kauppinen-Räsänen and Luomala, 2010). The evidence in the literature suggests that it is very important to understand how product colour drives product decision-making.

2.2.2 The meaning of colour in product packaging

The power of product packaging in marketing is that it interacts with the consumer at the point of purchase (Madzharov and Block, 2010; Kauppinen-Räsänen and Luomala, 2010) and consumers pay a lot of attention to the visual design of product packaging (Kreuzbauer and Malter, 2005). Their choices are found to be influenced by the design of aesthetic value. Product packaging is commonly viewed as an extrinsic product ‘user guide’ (Méndez *et al.*, 2011; Nath Kreuzbauer Sanyal and Datta, 2011). The ‘user guide’ is used as ‘information deliver’, which can have an impact on consumers’ assessment of product choices (Miyazaki *et al.*, 2005). Although there are many factors in product design such as texture, style, forms and function, colour is one of the most important for attracting customers (Hsiao, 1995). Current colour research in marketing has concluded that product colour (or packaging colour) attracts consumers’ attention (Grimes and Doole, 1998; Dantas, 2004), influences preferential judgments (Kauppinen-Räsänen and Luomala, 2010), and has the ability to communicate (Kauppinen-Räsänen, 2005). The product colour functions have been analysed in FIGURE 2.2.2. While, the impact of product colour (or the colour of product packaging)

varies according to product categories (Kauppinen-Räsänen and Luomala, 2010), age of consumers (Kauppinen-Räsänen, 2011) and nationality (Kauppinen-Räsänen and Owusu, 2012). The issue is that little is known of product colour, especially how colours can capture consumers' sight and affect their perceptions at every stage in consumer decision making (Englis *et al.*, 2005). Above these, the functions of product colour have been discussed.

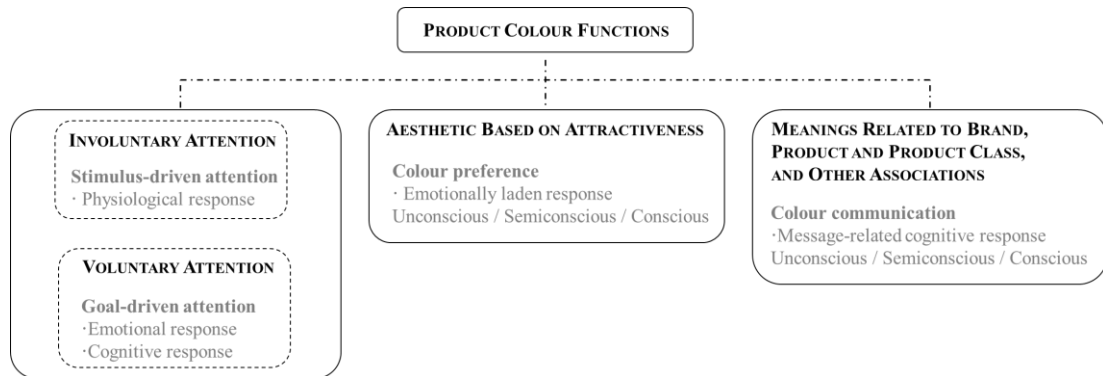


FIGURE 2.2.2 Product-colour's functions at the point of purchase (Kauppinen-Räsänen and Luomala, 2010).

2.2.2.1 Colour attracts attention

Attention is a complex topic that has received much attention in both popular literature and scientific studies. In 1890 William James wrote that 'Everybody knows what attention is' (Green, 2021). Yet, more than a century later, Hommel *et al.* asserted that (Hommel *et al.*, 2019). In between these two extreme statements, in 2011 Anderson claimed that there is no such thing as attention (Anderson, 2011). However, for the purposes of this thesis which is embedded in the discipline of design (rather than psychology) we can accept that attention is the process by which an individual allocates part of their personal cognitive resources (mental capacity) to a stimulus (Hoyer and MacInnis, 1997). It is generally accepted that attention can be a voluntary or involuntary process (Lindsay, 2020). In Figure 2.2.2, Kauppinen-Räsänen and Luomala (2010) specify involuntary attention as being stimulus-driven whereas voluntary attention is more of a goal-driven process and this is consistent with the view that voluntary and

involuntary attention probable have different mechanisms (Prinzmetal *et al.*, 2009). In terms of colour, therefore, it is reasonable to assume that it can attract through either involuntarily attention or voluntarily attention (Kauppinen-Räsänen, 2014). Involuntarily attention relates to the physiological effect of visual stimuli; that is ‘colour’s sensory effect’ (Schoormans and Robben, 1997), such as the simulation by high saturated colours, red or orange (see FIGURE 2.2.2). For example, Coca-Cola strengthened red as a colour to attracting involuntarily attention, which the red colour deviated from the conventional red of other cola brands (Kauppinen-Räsänen, 2014). Colour attracts voluntarily attention in a situation where colours are stored in memory (Kahneman, 1973; Kauppinen-Räsänen, 2014). On the one hand, as Kawasaki and Yamaguchi (2012) suggested, the colour response could be emotional that the voluntarily attention may be influence by colour preference. On the other hand, the colour response could be cognitive identification (maybe influenced by *colour association*, this will disuses in the following section) that the voluntarily attention may be used as a search instrument (product identifications) (Grimes and Doole, 1998; Garber *et al.*, 2000). For example, consumers recall memory when they perceive the use of brown in packaging for coffee.

2.2.2.2 *Colour is a source of attractiveness*

Colour is one of the essential aesthetic responses which has the ability to cultivate an emotional reaction, such as feelings of attractiveness to a product (Abbott *et al.*, 2009; Rocchi and Stefani, 2006). FIGURE 2.2.2 illustrates that product colour (packaging colour) may influence emotions at an unconscious level (innate), semiconscious level (culturally learned or life experience) or conscious level (personal colour preference based on personal experience) (Kauppinen-Räsänen and Luomala, 2010).

Generally, the assumption is that colour preference is an expression of personal taste, which means colour preference could evoke the emotional attractiveness responses (such as the feeling of attraction to a product) (Abbott *et al.*, 2009). Interestingly, Lee

and Lee (2006) supported the idea that consumers' *colour emotion* may also evoke an attractiveness response, and consumers' emotion may affect their *colour preference* or *colour association* (more details will be discussed in Section 2.2.4 and 2.2.5).

2.2.2.3 *Colour has the capacity to communicate*

Key marketing challenges include being salient and being able to communicate (Van der Lans *et al.*, 2008). Colour can, for example, indicate the nature of a product category (Schoormans and Robben, 1997). This seems to be particularly relevant for 'novelty seekers'- consumers who seek variety in their product choices (Garber *et al.*, 2000, Schoormans and Robben, 1997). One explanation of the communicative effect of product-colour is through cognitive associative learning (Grossman and Wisenblit, 1999). Memory is constructed as an associative network (Martindale, 1991), which connects two pieces of information together.

Product attributes and meanings are related to product categories and associated images. Association may explain why colours capture voluntary attention, or how colour becomes a means of communication (Grossman and Wisenblit, 1999). It may also explain (or associate) the link between product/packaging colour and product category/quality (Kauppinen-Räsänen, 2014). For example, the colour green is commonly accepted as a sign of nature. The colour green, therefore, is often used to denote nature and healthiness on so-called 'ECO' product packaging, as this forms a logical colour association. Details for association are reviewed in Section 2.4.4.

2.2.3 **The application of colour in the design of product packaging**

'How does the colour scheme of packaging influence consumer expectations of the product' (Wei *et al.*, 2014)? Colour has been extensively used in industrial design or product design (Luo, 2005; Jiang *et al.*, 2020). Using colour effectively to make products more appealing is a good strategy that is widely practiced in industrial and commercial (Hsiao, 1995). However, colour selection is a difficult decision for

designers, as consumers tend to expect different colours for different product categories and also in different cultures (Won, 2020). Haphazard colour selection may cause a negative aesthetic experience, or deliver the wrong message to consumers (Kauppinen-Räsänen, 2014; Hsiao, 1995). Although colour science has been widely used in a variety of industries over the years, it has not been fully explored in the field of product design. The Nippon Color and Design Research Institute (NCD) proposed the ‘Color Image Scale’ to investigate the feeling that colours can induce and demonstrated that a colour may have effects on different people (Kobayashi, 1981; Hsiao, 1995).

2.2.3.1 Enhancing design using colour

‘Not all colours are created equally’ (Best, 2017). Some colours in a product capture the attention much more readily (Wei *et al.*, 2014) and can stimulate consumers’ buying behaviour (Kuvykaite *et al.*, 2009). For instance, colour could enhance a consumer’s emotional experience of a product or their demand for a product (Cho and Lee, 2005). Consumer emotional experience and consumer demand are established as important factors in product colour decisions (Ding and Dong, 2019; Yang *et al.*, 2016).

Product colour may meet different consumers’ emotional (or demand) requirements and preferences by signifying product differentiation and diversification through modifying the product with different colours (Ding and Dong, 2019). Therefore, manufacturers and designers recognise product colour feedback as an important manifestation of products’ emotional design. Thus, accurately characterising consumers’ responses to product colour has become a significant consideration for product colour design. The above review suggests that valuable research could start to map a model between consumers’ colour perception and product-colour perception.

2.2.3.2 Understanding and forecasting colour trends in design

Colour trend forecasting has been used in industry for a long time. Perhaps the first commercial colour forecasting agency was the ‘Textile Color Card Association of

America' who produced colours for women's wear textile starting from 1915 (Kirberg, 2015). In the automotive industry, PPG Industries highlighted in their annual 'Automotive Color Trends' report that 35% of vehicles sold around the world were white whereas previously silver has been the most popular vehicle colour for several years. Today, colour trend forecasting is produced for different industries, typically 18 to 24 months in advance of consumption (Telegraph.co.uk., 2020).

In the other words, consumer taste is considered to be vital in product design. Trend forecasting assumes that this taste varies over time (with the Zeitgeist) and that this taste can be predicted by studying sociological and economical events. Trend forecasting attempts to enable designers to stay ahead of consumer demand and appeal to a diverse target audience for different products. Yet despite the importance of colour in design, relatively little is known about the accuracy of colour trend forecasting in particular product or product categories. Consequentially, colour trends have to be associated to each context (particularly for each product categories), to help to enhance an emotional experience or demand that consumer can relate to.

2.2.3.3 *Colour and human response.*

'In the application of colour, colour selections should take into account human response' (Best, 2017). While many designers are able to select colour and often do so very well (Wei *et al.*, 2014; Ampuero and Vila, 2006), few of them evaluate human response to product-colour as a tool to enhance behaviour or experience in a scientific or systematic manner. Designers undoubtedly use knowledge about human response intuitively without scientific evaluation. For example, designers may observe that people who live in a warm and arid climate may prefer cool colours for comfort. However, in-depth research could lead to know that the cool colour can provide them a better productive environment in that living situation (Best, 2017). That suggests, the exploration for product design needs to cover colour factors in supportive environments for human response in purchasing, using, athletic performance etc.

2.2.4 Summary for product colour

Colour becomes a design tool when planners and decision makers move beyond conventional appraisals such as ‘good or ‘bad’ and instead deal with and solve the communicative functions of colour perception and design. However, there is no method of calculation, no description model and no planning procedure by which the complex effects of colour in situ can be fully grasped. Additionally, there is no agreement on classification of package elements as well as research methods of package colour impact on consumer’s purchase decision. Moreover, some of work investigates all possible elements of package and their impacts on consumer’s overall purchase decision (such package shape, size, colour etc.), while others concentrate on every stage of consumers’ buying behaviour.

Although some studies demonstrate that colour is very important for products and their packaging, there is less established knowledge in terms of marketing. Traditionally, colours are selected based on designers’ experience, but this is thought to be subjective and sub-optimal (Hsiao, 1995; Won and Westland, 2017). Even the content of colour is often overlooked in the marketing area; however, the abundance of scientific literature on this issue does not provide the basis for a unanimous colour theory that could address the impact of product colour elements on consumers’ decisions. Additionally, diversity of the results in product colour research depends not only on colour theory itself, but also on the product categories too. In other words, consumer personal colour theory may be important, but their role in purchase decisions for different product category is less clear.

It is suggested that there would be benefit in developing a theory of colour and its effects on consumers in product design, product packaging and marketing. In the light of these problematic aspects, a *research problem* could be formulated with the following question: what elements of a product colour (colour theory) have an ultimate effect on consumer purchase decision? Despite there being many theories for designing colour schemes (or colour trend), these are still not fully understood, nor well tested,

and cannot be used effectively due to a lack of direct link to colour science. This, unfortunately, means that the above colour theories cannot be widely used.

2.3 Colour Theory

Section 2.2 concludes that the usage of colour in product (or packaging) elicits psychological responses and encourages different emotions and that these are important. However, there is a lack of any colour theory or framework that could be used to guide choices in practice.

Modern principles of colour theory appeared as early as the 15th century (Best 2017) though the contribution in 1666 by Isaac Newton is considered to be particularly vital (Luo, 2005). For many animals, colours seem adapted to their purpose of concealing themselves, either to avoid danger, or to spring upon their prey (Darwin, 1794); for humans, colour is a highly significant component in daily life (Best, 2017). It has been suggested that there are as many as ten million discernible colours (Judd and Wyszecki, 1975); however, others have suggested that the number is closer to 3 million or even that the number cannot be determined (Morovic *et al.*, 2012). However, the nature of colour and how it can be referred to is considered in the next section.

2.3.1 Colour ontology

‘Colour is the quality or attribute in virtue of which objects present different appearances to the eye when considered with regard only to the kind of light reflected from their surfaces’ (Oxford English Dictionary, 1989). Modern understanding of lights and colours was strongly influenced by Isaac Newton who demonstrated that white light is separated into seven distinct colours when it is passed through a prism (Luo, 2005). Colour is normally caused by light which is electromagnetic radiation characterised by certain wavelengths (Hanson, 2012; Westland *et al.*, 2007). However, the human visual

system only can sense a very small range of wavelengths, between approximately 360 and 780 nanometres (Westland *et al.*, 2007), see FIGURE 2.3.1(a).

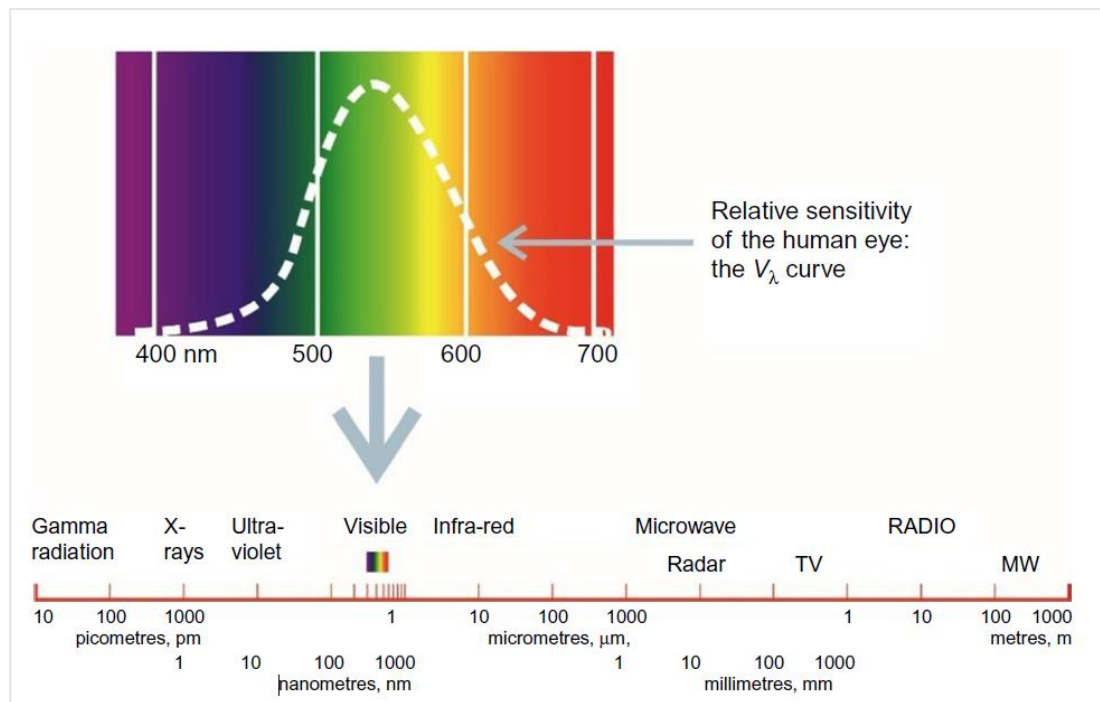


FIGURE 2.3.1(a) The electromagnetic spectrum described by wavelength together with the human visual spectrum (Best, 2017).

Vision is often considered to be the most important of the senses. For example, a larger part of the brain is devoted to processing vision than any of the other senses and colour is considered to be the most important aspect of vision. For example, it has been stated that ‘Colour appearance provides people with more information than all the other sensory perceptions combined’ (Buether, 2014). The human visual system captures colour information based on sensitivity to the energy carried by electromagnetic waves (Hanson, 2012). The visual experience of colour results from the interaction of light, materials, and the visual system (Bhowmik, 2017). However, not for nothing is sight known as the guiding sense in humans, as the brain constructs an environment language from the arrangement and variation of colour-coded retinal signals (Buether, 2014). When reflected or emitted light passes through the lens of the eye, it strikes the retina and is detected by photoreceptors known as rods and cones, see FIGURE 2.3.1(b)

(Ebner, 2007). However, colour perception can include complex psychological effects. For example, in very bright conditions, things become more colourful (the Hunt effect). By contrast, colours are seen less clearly in dim lighting conditions (such as the glitter, starlight and moonlight), and in very dark environments humans can only perceive greyscale colours (Holtzschue, 2012; Berns, 2000; Hunt and Pointer, 2011).

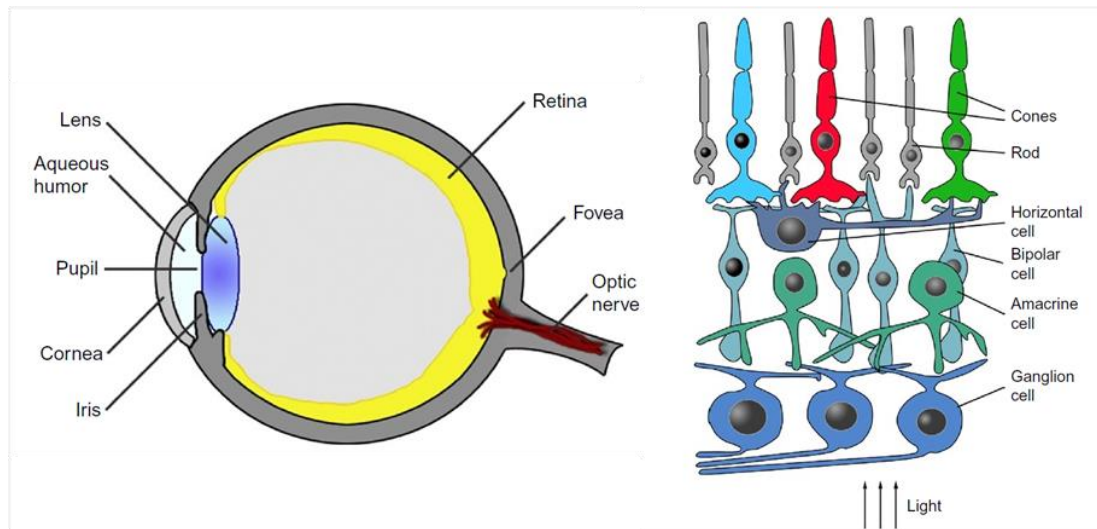


FIGURE 2.3.1(b) Structure of the eye and the retina layers (Best, 2017).

2.3.2 A history of colour theory in Art, Science & Design

Colour theory principles appear as early as the 15th century with notable contributions from the paintings of Leonardo da Vinci (Lamb and Bomford, 1995; Cuthill and Troscianko, 2011). A greater prominence of ‘colour theory’ begins in the 18th century following Isaac Newton’s work (Brebba *et al.*, 2011). He introduced important ideas about colour mixing and also produced the first colour circle (Luo, 2005). However, colour theory has been widely connected between Newton’s studies and Turner’s use of it. Newton epitomised the ‘rock-like status of knowledge’ (Desmond, 1997); and of Turner ‘no artist has had a more passionate interest in colour’. Eastlake, the ‘scientific friend’ who became President of the Royal Academy in 1850 and the first Director of the National Gallery in 1855 (Van Goethe, 2006), expressed how impressed he was, in the preface of *Theory of Colours*, by Goethe’s extensive experiments on colour (Von

Goethe, 1840).

Over the last five centuries, over 3000 books about colour have been published by scientists, technologists, artists, designers, educators, historians, naturalists and physicians (Buether, 2014). Since its inception in 1931, the Commission Internationale de l'Eclairage (CIE), the body responsible for international standards for colour science, recommended the first colour specification system. It was not practically used to any great extent until 1960, when digital computers became available. Nowadays, colour science is widely used in a variety of industries such as textile, paint, plastic, packaging, paper, lighting, television, colorant, food, ceramic, cosmetics, etc. (Luo, 2005).

Both the pure arts and practical design fields are highly concerned with colour (Hsiao, 1995). In practical design, colour is both a phenomenon and a medium of visual perception and communication (Wei *et al.*, 2014). As a phenomenon, colour builds the environment experience visually, while as a medium, it contains meaning, emotional moods and functional information (Buether, 2014).

2.3.3 Colour description and communication

If a group of children are asked to organise a collection of coloured chips, they will probably become confused since they will only be familiar with a simple order system comprising the sequence of rainbow colours (red, orange, yellow, green, blue, indigo and violet) which does not include colours such as flesh tones, white, black, purple, brown and pink. It is challenging to organise lighter and darker colours, or colours that are more or less colourful, in a 1-D line (Best, 2017). It is now understood that colour perception has three dimensions, so that each colour is specified by a unique triplet of values. These three dimensions relate to hue, lightness and chroma.

The practical applications of colour from physical, psychological, philosophical, semiotic, cultural historical and sociological findings are helpful in the design process (Cuthill and Troscianko, 2011). However, in modern design, colour only becomes a tool if the designer has extensive theoretical knowledge that they can combine with their

own practical experience (Buether, 2018). Training is available in both theoretical knowledge and practical skills, colour description and communication of scientific (Westland, 2007), technological (Luo, 2005) and methodological strategies (Won and Westland, 2018) have been detailed.

2.3.3.1 *Colour systems*

In 1672, Newton published his work ‘Opticks’, which has formed the basis of our modern understanding of colour. Newton introduced important ideas about colour mixing and also produced the first colour circle. In the early 20th century, Ostwald built a system in greyscale and applied each hue on a colour circle with 24 hues concerning black and white value. In 1929, Albert Munsell developed further a 3-D colour sphere with hues arranged in a circle and with the more vivid colours placed further away from the central white-black axis (Tzeng and Berns, 2000).

There is now a plethora of colour systems. Some of these, such as Munsell and NCS, have an associated colour space. Others, such as Pantone, have no colour space but are used widely to aid colour communication. Systems such as ColourTalk and DigiEye are used to allow colour information to be electronically transmitted (see FIGURE 2.3.3.1) to factories for colour reproduction with great precision, or to communicate with the other designers for proofing (Luo, 2005). Traditionally, the process involves many physical samples with different types of substrates, different sizes and textures. This requires a large working space, technicians, expensive sample preparation and a long delivery time.

Such a plethora of systems exists in part because no single colour order system satisfies the requirements of all users; rather specialist colour spaces have been developed for specific groups of people (Best, 2017, Buether, 2014). The development of these colour systems, in the wide visual science of colour appearance, enables us to investigate how colours influence each other and how different presentations affect human colour perception (printed, self-luminous displays, etc.). However, central to all of these

systems is the CIE system which is discussed in the next section.

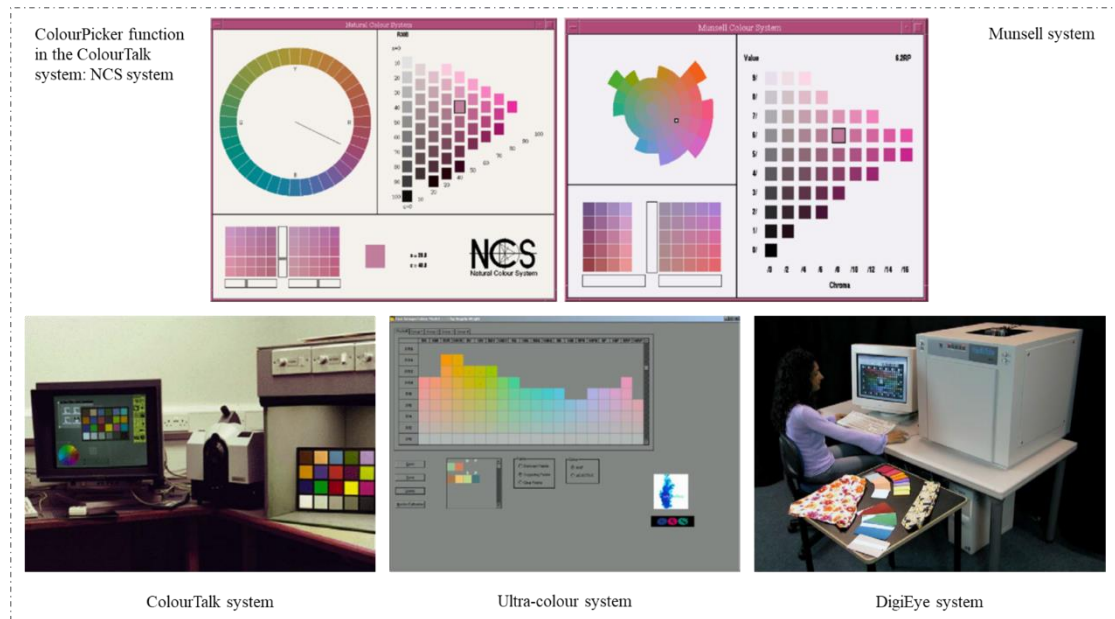


FIGURE 2.3.3.1 The colour systems researchers and designer used in their work.

(Luo, 2005).

2.3.3.2 Colour Space

The CIE is an international standards organisation on light, which set out to standardise and to produce a method to specify colour stimuli. It allows colour to be measured by various colour instruments, generally classified as tristimulus colorimeters, spectroradiometers, and spectrophotometers (Zwinkels, 1996). The chromaticity diagram is an example of a colour space that aims to physically capture and locate the full range of human colour perception. However, application specific colour spaces such as Adobe RGB, Adobe HSB and CMYK space (designers' familiar colour space) define sub-regions of that full-colour space limits by their colour gamut (Chen *et al.*, 2013).

For example, HP and Microsoft cooperatively established an RGB colour space called sRGB (standard Red, Green and Blue) in 1996, which is widely used in the visual computer systems, television and the internet. The Adobe RGB colour space was developed by Adobe Systems, Inc. in 1998, which was designed to include the most of

colours achievable on CMYK colour printer by using a computer display. The sRGB, Adobe RGB and CMYK colour spaces were located in Figure 2.6 (Chen *et al.*, 2013; Yurek, 2015).

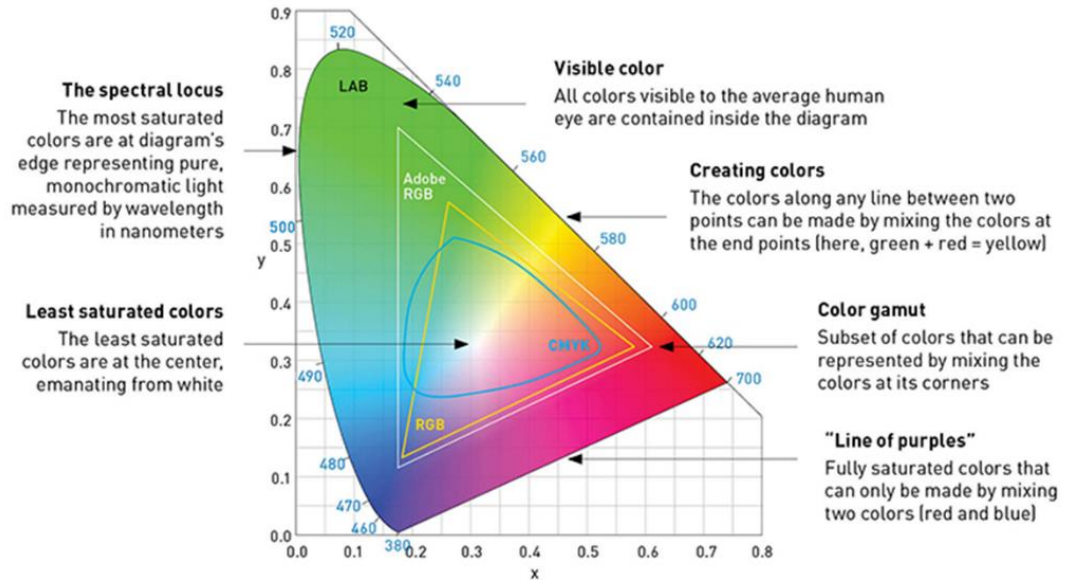


FIGURE 2.3.3.2 The application-specific colour space such as Adobe RGB and CMYK space as sub-region of that full-colour space with the limits by their colour gamut (Yurek, 2015).

2.3.3.3 Colour standard, measurement and difference

In many cases, researchers and designers are concerned with the colour differences between a pair of colours. This is often of practical significance since whether two coloured samples match is often of great commercial importance. Colour difference evaluation is essential for control (Tzeng and Berns, 2000).

In the CIE system, each colour stimulus is specified by three tristimulus values known as X, Y and Z (Ford and Roberts, 1998). In the chromaticity diagram, a two-dimensional space has been introduced for easy visualisation, which has two co-ordinates: x and y (thus, $x = X/(X+Y+Z)$ and $y = Y/(X+Y+Z)$) (Wang, 2018). The CIE $L^*a^*b^*$ and CIE L^*C^*h colour spaces were recommended by CIE (Ford and Roberts, 1998) in 1976. CIE $L^*a^*b^*$ consists of a set of three-dimensional orthogonal coordinates: L^* , a^* and b^* ; L^* represents lightness (values of 0 and 100, represent a black and a reference white

respectively), a^* and b^* represent the redness to greenness and yellowness to the blueness of the colour (Kim and Nobbs, 1997; Luo, 2005). The L^*C^*h shown by L^* , C^* and h , which C^* indicates chroma and h represent the hue angle (Wang, 2018). In order to compare two different colours, the measurement of colour distance in colour space has been used widely. In particular, the CIE normalised colour difference as a distance metric Delta E (or ΔE) in CIELAB colour space. The equation is:

$$\Delta E_{ab}^* = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$



FIGURE 2.3.3.3 Three typical spectroradiometers: X-Rite i 1 Pro, Konica-Minolta CS-100A and Konica-Minolta CS2000.

Three spectroradiometers, X-Rite i 1 Pro (for example), CS-100A and CS2000 are shown in FIGURE 2.3.3.3. However, in this research, a handheld CS-100A portable instrument has been used (for details see Section 3.3.3)

2.3.4 Colour information

Section 2.2.2 revealed that colour plays a critical role in the perception of product; it has the ability to attract attention and to communicate. It is evident that colour is a medium for conveying information in product design (or packaging), rather than being only a tool to deal with or solve ‘beautiful’ or ‘ugly’ questions etc. (Buether, 2014). In other words, it is not just about aesthetics. However, it is unknown exactly what kind

of colour information is delivered to consumers and what effect it has. In other words, what kind of colour information could colour contain, and how colour theory supports the information delivery?

It has been suggested that *colour information* could engage with the visual element of products in three levels: reducing uncertainty, abstracting patterned and generating knowledge (Turner, 2006). However, Won and Westland (2018) suggested *thirteen types* of colour information in colour academic fields (Appendix A): *Colour in art and design* (section 2.3.2), *Colour harmony*, *Colour history* (section 2.3.2), *Colour and light* (section 2.3.1), *Colour meaning*, *Colour measurement* (section 2.3.3), *Colour notation*, *Colour perception*, *Colour preference*, *Colour printing*, *Colour psychology*, *Colour theory* (section 2.3) and *Colour trend*). However, it is hard to use all the extracted ‘colour information’ in this research, *colour history* or *colour printing* for example (the background and development for a particular colour, Blaszczyk, 2012; the colour quality or print techniques of colour printing, Parraman, 2012); such as the product is a new created-product (Gijsenij *et al.*, 2021, Luchs *et al.*, 2015) or a Network-product etc (Luchs *et al.*, 2015).

On the other hand, two types of colour effect have been proposed in the context of product design: a directed value (colour’s direct effect on people) and an associative value (where people associate a specific thing or other phenomena of high symbolic and emotive value) (Kandinsky, 1977). To investigate the colour directed value, *colour preference* has been chosen; additionally, *colour meaning* and *colour psychology* have been chosen to investigate the *colour associative* value. Details are discussed in the following section.

2.3.5 Summary for colour theory

The review of the literature has demonstrated that colour theory could act as a scientific tool to investigate the role of colour in product design or product packaging. For example, *colour system* and *colour space* apply the in the wide visual science of colour

appearance and colour selection; *colour standard* and *colour measurement* apply the comparison between colours to enhance the researchers' or designers' communication etc. Therefore, to examine how colour visual perception in products might associate with different psychological responses or emotions with obtaining useful information for future applications in a pre-selected context with a wide range of colours examined (or we say for specific products).

However, colour visual perception for a product is subjective in that it reflects individual experiences and objectives, and presents socially accepted knowledge and empirically verifiable observations. Furthermore, the effect may be influenced by people of different nationalities, cultures or even with different gender, age, education level, experience, and individual character. It could be argued that the optimal selection of colour for a product might depend upon characteristics of the end user (demographics defined by attributes such as wealth, religion, and other social groups). The topics *colour preference* and *colour meaning* are detailed in the following section.

2.4 Understanding colour perception and preference

Section 2.3 reveals that colour theory that may help to explore (and explain) the role of colour in products; in particular, *colour perception* may attract consumers' attention and enhance their reaction to the product (Imram, 1999; Webster, 1996; Zeki, 2002). On the other hand, consumers' product colour visual perception reflects individual preferences, experiences or associations etc. However, the colour perception may vary between people, because certain colours are associated with meanings and behaviour which may differ across social groups (Osborne, 2012; O'Connor, 2010). To further understand these differences, *colour preference* and *colour association* are reviewed in this section to investigate and explore their potential application in product colour design.

2.4.1 Colour preference research strategy

Individual colour preference is concerned with which colours individuals prefer among alternatives (Mikellides, 2012; Ou and Luo, 2003) and has been studied by many researchers for more than 100 years (Guilford and Smith, 1959; Ling *et al.*, 2006). Although there are some general trends (for instance, people tend to prefer cool colours such as blue and dislike warm colours such as yellow and orange) individual colour preferences vary from person to person (Grieve, 1991). There are also some studies that show that gender (Ling *et al.*, 2006; Fortmann-Roe, 2013; Al-Rasheed, 2015; Bonnardel *et al.*, 2010), culture (Ou *et al.*, 2012; Yokosawa *et al.*, 2010; Bonnardel *et al.*, 2010; Al-Rasheed, 2015), context (Jonauskaite *et al.*, 2016) etc. may affect individual colour preferences.

Finding an efficient way to understand individual colour preference is important to researchers (Lee *et al.*, 2009; Liu *et al.*, 2018; Pan and Westland, 2018) and designers (Hemingray *et al.*, 2019; Luo *et al.* 2019). In the field of individual colour preference, modern studies have used standardised colours (Hurlbert and Ling, 2017), multiple experimental methods (Palmer *et al.*, 2013; Choungourian, 1968; Holmes *et al.*, 1985), and sophisticated statistical methods (Ou *et al.*, 2004 (a); Yu *et al.*, 2018). Strengths and weaknesses of experimental methods/ behaviours/ techniques are presented and discussed in the following text. Major findings from individual colour preference studies are reviewed, including colour strategies, experimental methods, experimental materials and results. The populations, the task (responses behaviour, experimental methods, experimental samples (or materials), experimental environment and participants must be specified prior to collecting data. The displays/materials could be virtually any physical objects or images. The behaviour responses/experimental methods are probably forced-choice, ranking description of like or dislike. TABLE 2.4.1 highlights 28 papers on colour preference research (five pages).

TABLE 2.4.1 Twenty-eight papers on colour preference research.

Researchers	Colour model name	Hue	Saturation (levels)	Lightness (levels)	Number of colours	Experimental materials	Method	Experimental environment	Repeat test	Number of Participants	Main findings
Walton <i>et al.</i> (1931)	Munsell Colour	18 spectral hues	No	No	18	Milton Bradley Coloured papers (9 cm. squares)	Paired-Comparison	-	No	1279	-Female's colour preferences are somewhat more inclined to fluctuate from one year to another than are the male's -Certain differences between the two genders in colour preference persist rather consistently from one year to another; such as, male usually prefer orange to yellow, female preference is reversed.
Shen (1935)	-	6 hues	No	No	7	Coloured cardboards	Paired-comparison	-	No	1368	-The descending order of preference is: white, red, blue, green, orange, yellow, and violet. -Boys prefer Green, Blue, and Violet more strongly, girls prefer White, Red, Orange, and Yellow more;
George (1938)	-	6 hues	No	No	7	Milton Bradley standard Coloured papers (1/2 in.in diam)	Rank-order	-	No	500	-Colour preference order is: blue, green, red, yellow, orange, violet and white; -No difference between gender and art training.
Eysenck (1941)	-	6 hues	Yes	Yes	10	Oswald coloured papers	Rank-order	-	No	12 + 30	-More saturated colour were generally preferred; -Male and female agree in placing blue, red, green, and violet above the two other colours; male prefer yellow to blue colours, female prefer orange; -The nationality might be an effect element.
Warner (1949)	Munsell colour model	4 hues	Yes	Yes	36	Munsell standard colour paper (5*8 in.)	Paired-comparison	25-watt daylight blue Mazda Lamp	No	300 in total, 120 (Schizophrenics) 60 (Anxiety) 60 (Depressed) 60 (Manic)	-General hue preference: blue, green, red and yellow; -Male hue preference: blue, green red and yellow, female hue preference: blue, red, green and yellow; -Male preferred cool hues and female preferred warm hues;
Granger (1955)	Munsell and CIE systems	10 hues	Yes	Yes	214 (hue test); 160 (lightness test); 59 (chroma test)	Coloured chips (17mm*12mm)	Rank-order	Physical Laboratory with 2840-6500*K colour temperature	No	50	-There is a general order of colour preference; -No marked sex difference in colour preference.

Researchers	Colour model name	Hue	Saturation (levels)	Lightness (levels)	Number of colours	Experimental materials	Method	Experimental environment	Repeat test	Number of Participants	Main findings
Guilford and Smith (1959)	Munsell colour model	10 hues	Yes	Yes	316	Coloured paper	Affective judgments (11 point-scales)	four 60w frosted bluish Mazda bulbs	No	40 (20 males and 20 females)	-Preferences were highest in the region of green to blue and lowest in the region of yellow and yellow-green, when brightness and saturation are held constant; -Male and female have a similar colour preference, the only difference appeared on red-purple colours; -Men rated colours generally higher than women;
Choungourian (1968)	Ostwald	8 hues	No	No	8	Coloured cards (10*10 cm)	Paired-comparison	A 100-w mat lamp fixed at a 120 cm distance	No	160	-Culture background have colour preference difference; -Overall colour preference order is green, blue-green, red, yellow-green, orange, blue, yellow and purple; -Gender has difference, male prefer blue than female.
Child et al. (1968)	Munsell	-	-	-	35 pairs	Coloured patches	Paired-comparison	-	No	1053	-Consistent preference for cool hues and high saturation; -Female preference for lighter colours; -The colour preference influence by hue first, then saturation.
Helson and Lansford (1970)	Munsell	20	Yes	Yes	125	Coloured chips	Rating	5 conditions (2854K, 3000K, 4500K, 6500K and 6800K)	No	10 (5 males and 5 females)	-Male and female differed significantly in their colour preferences; -Males prefer cool colours, females prefer warm colours; -High chroma or saturation is preferred to low chroma.
Saito (1983)	PPCC (practical Color Co-ordinate System)	10 hues	Yes	Yes	50	Colour chips (90*256 mm)	Bipolar adjectives (3 scales)	Daylight illumination of 500 lx measured at the board	No	41 (28 males and 13 females)	-All blue tone, deep red and white highly preferred both with and without content; purple, red-purple, deep-yellow and light-blue-green low preferred both with and without content; -With content, participants prefer neutral colours which influence by tone rather than hue; without content, the influence from tone and hue were similar.
Holmes and Buchanan (1984)	-	-	-	-	-	Colour words (no materials applied)	Description	-	-	89 (31 males and 58 females)	-The present results clearly showed blue to be the favoured overall colour for males and females; -Participants' favourite colour would not be always picked for a variety of objects; -The author thinks colour preference can not be asked independently of an object if that colour preference is to have interpretive significant.

Researchers	Colour model name	Hue	Saturation (levels)	Lightness (levels)	Number of colours	Experimental materials	Method	Experimental environment	Repeat test	Number of Participants	Main findings
Holmes <i>et al.</i> (1985)	Luscher test colour	-	-	-	8	Colour patches	Rank-order	-	Yes	1143	-Gender has a different colour preference. Female psychiatric clients at all age prefer yellow; males prefer blue; -Age has a different colour preference. Young males prefer blue, old males prefer red and blue equally.
Adams (1987)	Kodak Wratten Filters	4 hues	No	No	5	Rear-projection screen (41*29 cm)	Paired-Comparison and Affective judgments	-	No	80 (60 infants and 20 adults)	-Colour preference in infants and adults are different; -Adults prefer blue colour; -Colour preference may change/influence by future study.
Taft (1997)	NCS Color Atlas	8 hues	Yes	No	13	Digital colour chips	7-step semantic scales	-	Partly repeat	20	-Most of the results for colour preference related to product-colour preference; -The preferred colours may not suit put on some products;
Camgöz <i>et al.</i> (2002)	HSB	8 hues	Yes	Yes	63	Computer monitor	Force-choice	-	No	123	-Blue is the most preferred hue; -The effects from hue are higher than brightness and saturation on preference on a specific background colour; hue, brightness and saturation has an effect on preference on a specific background colour; -Gender does not have an effect on colour preference.
Ou <i>et al.</i> (2004)	NCS Color Atlas	-	Yes	Yes	20	Colour patches 3*3 inch	Bipolar colour-emotion scales	Viewing cabinet illuminated by a D65 simulator	No	31	-Different culture background represents different colour emotion results; -Chinese participants tend to prefer colours that cleaner, fresher or modern; whereas this didn't occur for British participants;
Hurlbert and Ling (2007)	-	8 hues	No	No	8	Neutral CTR display	Force-choice	-	Two weeks	208	-Participants have a high preference for bluish colour; -Gender has differences in colour preference. Females prefer 'red'-'green', males prefer 'blue'-'yellow'; -Different colour preference may be modulated by cultural background / individual experience.

Researchers	Colour model name	Hue	Saturation (levels)	Lightness (levels)	Number of colours	Experimental materials	Method	Experimental environment	Repeat test	Number of Participants	Main findings
Palmer and Schloss (2010)	Berkeley colour system	8 hues	Yes	Yes	32	-	Rating (-100 to 100)	-	No	48	-Participants prefer blue colours, high-saturation colours, and higher lightness colours; -Colour preference can be changed by study or by showing people a biased sample of pictures of coloured objects; The sociocultural institutional affiliation could influence colour preference during lifetime; -People like colours strongly associated with objects they like (e.g. blue with clear-sky and clean-water), dislike colours associated with objects they dislike (e.g. browns with faces and rotten food).
Taylor and Franklin (2012)	Munsell colour system	8 hues	Yes	Yes	24	21-in. CRT Monitor	Affective judgments (11 point-scales)	-	No	42	-For the colour preference, males WAVE appears to capture colour preference better than females; -There was a significant negative correlation between colour preference and the number of associated objects; colours associated with few objects are more likely to be liked than colours associated with many objects.
Taylor et al. (2013)	Munsell colour system	8 hues	Yes	Yes	16	21-in. CRT Monitor	Eye tracking, Paired-Comparison and Line-mark scale	-	No	153 (30 infants and 123 adults)	- Little evidence that adult colour preferences are evident in infants' preferential looking responses to colour; -Infant hue preferences interact with lightness; -Colour preference may influence by object association, basic psychophysical dimensions and biological components of colour vision.
Yokosawa et al. (2015)	Munsell system	8 hues	Yes	Yes	32	Apple iMac MB324J/A	Rating	-	No	88	-Multicultural colour preferences were intermediate between U.S. and Japanese preferences, consistent with the hypothesis that culturally specific personal experiences during one's lifetime influence colour preferences;
Lee et al. (2016)	-	8 hues	-	-	11	Coloured cards	Rank order	Experimental room	No	30	-The elder group differed from younger group in colour preference order; - Elder observers' colour preference was determined according to chroma attribute. Younger observers' colour preference was connected to lightness attribute;
Jonauskaitė et al. (2016)	-	-	-	-	-	Colour Edge CG243W 24.1" Widescreen LCD displays	Colour picker (Force-choice)	Experimental room	No	85	-For general colour preference, participants prefer red colour and green-blue colour; -Colour preferences should be studied in context when the interest lies in colour preferences for a specific object

Researchers	Colour model name	Hue	Saturation (levels)	Lightness (levels)	Number of colours	Experimental materials	Method	Experimental environment	Repeat test	Number of Participants	Main findings
Schloss <i>et al.</i> (2017)	Berkeley Colour	8 hues	Yes	Yes	37	Dell LCD monitor	Rating	A dark enclosed testing room	Yes	39	-Colour preferences change according to season, as colour-associated objects become more/less activated in the observer.
Zhang <i>et al.</i> (2019)	Munsell	7 hues	Yes	Yes	31	Coloured paper	Affective judgments (9-point scale)	Under D65	No	1290	-The general preference order for saturated colours were as follows: red & cyan & blue > green > white & yellow & purple > orange > black > gray; -There were cultural and psychological differences between participants from northern and southern China; - The change in preference for dark colours, muted red, muted orange, muted yellow and light colours (except for red) happened early in middle adulthood. While the preference for light red, dark colours, muted blue, and muted purple changed only in old age.
Nemcsics and Takács (2019)	Coloroid system	6 hues	No	No	6	Coloured card	Paired-Comparison	a room lit by light reflected	No		- The difference between the measures of preference for various colours in 1967 is greater than that in 2017. - The green colour was preferred more than any other colours by the age group of 50 to 80 years both in 1967 and in 2017.
Jiang <i>et al.</i> (2020)	NCS (Natural Color System)	4	Yes	Yes	21	Online Questionnaires	Rating	No	No	348	-The most favoured colours for children were white, light yellow, light blue, and light red; -Colour preference has a significant impact on children's furniture colour choice;

2.4.1.4 Colour selection strategies

In order to select colour samples, the Munsell colour system (Walton *et al.*, 1933; Guilford and Smith, 1959; Taylor and Franklin, 2012; Zhang *et al.*, 2019), the NCS Colour Atlas (Ou *et al.*, 2004; Taft, 1995), and the HSB colour system (Camgöz *et al.*, 2001) are frequently used. The three primary dimensions of colour appearance which are sufficient to distinguish one colour from another in terms of perception - hue (basic colour), saturation (vividness, purity or chroma), and brightness (lightness or value) – are also used (e.g., Guilford and Smith, 1959; Hurlbert and Ling, 2007; Ou *et al.* 2004; Palmer and Schloss 2010; Zhang *et al.*, 2019). Studies often focus on as few as six (red, orange, yellow, green, blue and purple) or eight (red, orange, yellow, chartreuse, green, cyan, blue and purple) hues. Additionally, one or two levels of saturation and brightness dimensions are sometimes explored in colour preference research. In this research, an eight-hue colour strategy is used (for details see CHAPTER 3, section 3.4.1.).

2.4.1.5 Experimental environment strategy

In terms of experimental materials (colours) studies have compared between 6 to 316 coloured samples (Shen, 1935). The nature of the coloured samples/materials could be colour chips (Saito, 1983), colour cards/papers/fabric or digital colour patches displayed on a computer monitor (Taylor *et al.*, 2013). The experimental environment is often a restricted/controlled experimental place and lighting conditions, such as a Physical Laboratory with 2840-6500K colour temperature (Granger, 1955) or a Darkroom with a D65 simulator (Ou *et al.* 2004 (a)). Some studies have used less controlled environments, such as an online survey (Jiang *et al.*, 2020) etc.

2.4.1.6 Experimental method strategies

The experimental methods that have been used can be classified as N-alternative forced-choice (N-AFC, $N \geq 2$), rank-order, affective judgments (or bipolar adjective), subjective

rating and other tasks. In some respects, the optimal experimental method is N-alternative forced-choice (Palmer *et al.*, 2013), in which participants indicate which colour they ‘*like better*’ (or prefer aesthetically) with all colours simultaneously presented on a visual display (Jastrow, 1897; Walton *et al.*, 1933; Chou and Chen, 1935; Shen, 1935; Warner, 1949; Camgöz *et al.*, 2002; Yu *et al.*, 2018). The average probability/percentage of choosing each colour over all others is a global measure of colour preference. N-AFC paradigms have the advantage of requiring a simple response to indicate choices, impose no memory load and are subject to minimal response bias effects. The 2-AFC is a special case of the N-AFC method and is also called ‘Paired-Comparison’ (Adams, 1987; Ling and Hurlbert, 2006). The 2-AFC task has the advantage of requiring a simple response to indicate the choice from only two samples. However, the primary drawback is that when the complete matrix of comparisons is carried out, the work required becomes prohibitive with a large number ($N(N-1)/2$) of paired comparisons needed for N stimuli (David, 1987). Thus, when the number of stimuli is high, investigators sometimes conduct so-called incomplete pair-comparison experiments (Dittrich *et al.*, 2012).

The other common method is a rank-order task in which participants are required to order all colours from the most to the least preferred for all colours simultaneously displayed (Eysenck, 1941; Granger, 1955; Holmes *et al.*, 1985). The advantage is that participants provide more quantitative information than from a single trial in which they simply indicate the most preferred sample. The disadvantage, on the other hand, is that each single trial may be complex, requiring simultaneous presentation of all N colours (if the colour number is large/or spatially complex) and a potentially long and complex judgement.

The Rating method of colour preference is another alternative paradigm. Rating and affective judgments (or bipolar adjective) could be made on response scales of given resolution (such as an N-point Likert scale) (Guilford and Smith, 1959; Hogg, 1969; Saito, 1983; Adams, 1987; Ou *et al.*, 2004 (a); Ou *et al.*, 2004 (b); Ou *et al.*, 2004 (c);

Taylor and Franklin, 2012) or continuous scales (such as a line-mark rating) (Adams, 1987; Taft, 1995). Participants are shown a single colour on each trial and asked to rate how much they prefer or like it (Palmer and Schloss 2010). The average rating for each colour is calculated as the measurement of colour preference. The responses for each colour are simple; however, it might be difficult for participants to make consistent ratings across trials, especially at the beginning of task. Other measurement methods include description methods (participants are asked to provide the name of the colour they most prefer), physical and behavioural measurements (often used for infant colour preference, where the length of time they look at a colour is used as an indicator of preference), and so on (Holmes and Buchanan, 1985).

2.4.2 General individual colour preference

In terms of hue preference results, cool colours (such as green and blue) are generally preferred to warm colours (such as orange and yellow), with maximum preference at blue and minimum preference at yellow-green (Dorcus, 1926; Eysenck, 1941; Guilford and Smith, 1959; Hogg, 1969; Ling *et al.*, 2006). For saturation (or chroma), some findings have suggested that adults generally prefer colours of higher saturation to those of lower saturation colours (McManus *et al.* 1981; Ou *et al.* 2004 (a); Palmer and Schloss 2010).

However, some research suggests that colour preference decreases for very high saturation colours which are sometimes reported as being ‘too vivid’ (Granger, 1955; Palmer and Schloss, 2013). Brightness (lightness) is confounded with saturation across hues. Some research has suggested that adults tend to prefer colours of increasing brightness (at least to some point) (Guilford and Smith, 1959; McManus *et al.*, 1981); however, the effect is not always evident (Palmer and Schloss, 2010). Recent studies tend to agree that colour preferences are universal (the ‘blue phenomenon’ refers to the tendency to choose blue as the most favourite colour). However, some studies have found that colour preferences are not universal. Saito (1996) suggested that cultural

differences might influence colour preference. Ou *et al.* (2012) thought cultural difference and personal taste should also be taken into consideration.

A number of studies have suggested that there is a universal individual colour preference across cultures (Eysenck, 1941; Satio, 1996), genders (Mohebbi, 2014; Mikellides, 2012; Dittmar, 2001) and age levels (Teller *et al.*, 2004). Eysenck (1941) found that Caucasian and other races have the same individual colour preference ranking order: blue, red, green and purple. Saito (1996) found that white and blue were the most preferred colours in Japan and Korea. Mikellides (2012) analysed existing studies to derive general conclusions for individual colour preference, and concluded that blue is the most popular colour for both genders, and yellow is the least popular colour.

Across age levels, for children (infants) there is gender effect; they all prefer warmer colour (Franklin and Davies, 2006; Teller *et al.*, 2004). However, some studies concluded that different cultural backgrounds lead to different individual colour preferences. Child and Iwao (1969) found there were colour saturation and brightness preference differences between Japan and USA. Ou and Luo (2003) found that UK prefers 'cool' colours, and Chinese prefer 'clean', 'fresh' and 'modern' colours by analysing *colour emotion* data.

Between genders, for children, Burkitt *et al.*, (2003) noted sex differences; girls preferred pink and boys much prefer light blue. For adults, Ling *et al.* (2006) found that females prefer more reddish colours than males, and males prefer more bluish colours than female. For the age levels, Lee *et al.* (2009) found that young people prefer light colours and elder people prefer dark colours. Dittmar (2001) reported that the colour preference tends to be stable for adult people, but blue colour preference starts to decrease, and turn to prefer green and red as people enter old age (Strauss *et al.*, 2013; Nemcsics and Takács, 2019).

2.4.3 Explanation for Individual Variation in Colour Preference

Generally, the colour preference order for saturated colours is typically as follows: red/cyan/blue > green > yellow/purple > orange, and light colours are preferred the most, followed by saturated, muted, and dark colours (Zhang *et al.*, 2019).

However, individual colour preference might be influenced by many factors. Several types of explanation have been suggested: physiological factor (Ling *et al.*, 2006), psychophysical factor (Palmer and Schloss, 2009), emotional factor (Ou *et al.*, 2004), ecological hypotheses (Palmer and Schloss, 2012) and etc. Some of them are not dependent variables, the factors might influence each other most of the times. Based on an understanding of the literature are briefly discussed.

2.4.3.1 Biological adaptation theory

The most physiologically factor-based theory suggests that personal colour preference depends on the weighted average of cone contrast. Initially, researchers found that the retina for male and female are different for processing colour information. Humphrey (1976) proposed that colour preference could be used as a signal on the creatures in the natural world. Hurlbert and Ling (2007) supported this view and go further. They found females prefer reddish colours (L–M contrast component, ‘red-green’, where S, M, and L refer to the output of the short-, medium-, and long-wavelength cones) more than males; and males prefer blueish colours more than females (S–(L+M), ‘blue-yellow’). They also developed the evolution-adaptive theory (the relation between individual hue preference and the cone-opponent contrast component in the human visual system), which colour preference might influence by behaviour adaptive.

2.4.3.2 Colour emotion factor

Another explanation has been constructed in terms of the emotional associations of colours. Thus, people may prefer colours to the extent that they prefer the emotions that are evoked/associated with those colours. Ou *et al.* (2004) measured colour-emotion

scales (three factor-analytic dimensions: active-passive, light-heavy, and cool-warm) by subjective rating, and used those rating to predict colour preferences. However, they did not discuss how or why colour-emotions arise or predict colour preference than others. In some case it is surprising, for example, the more desirable emotions (happy) are associated with less preferred hue (yellow), whereas the less desirable emotion (sad) is associated with more desirable hue (blue) (Terwogt and Hoeksma, 1995).

2.4.3.3 *Ecological valence theory*

Palmer and Schloss (2010) suggested that colour preference is based on meanings that colours have (psychophysical factor and ecological hypotheses). They suggested the ‘eco-valence theory (EVT)’ to explain the variation in individual colour preferences in terms of on biological adaptation. Additionally, human colour preference may not only explain individual colour preferences but suggests that colour preferences might be impermanent (varying over time and with the context). EVT is supported by an empirical data from where the colours people preferred strongly linked with objects they like (such as blues with a clear sky and clean water) and the colours people dislike strongly linked with objects they dislike (such as browns with faeces and rotten food). Also, several further predictions (Palmer and Schloss, 2012) of the EVT have been confirmed that colour preference could be changed by exposure to affectively biased colour objects if preferences for coloured-objects causally influence the corresponding for colour preferences.

2.4.3.4 *Age*

Although some studies have suggested that colour preference remains stable across the lifespan (Dorcus, 1926), other studies have concluded that colour preference may vary between older and younger adults (Lee *et al.*, 2009). One of the reasons is that, colour vision is known to change as human’s crystalline lens ages (Roy *et al.*, 1991; Zhang *et al.*, 2019); the lens allows less light to reach the retina, especially for shorter

wavelengths (Hardy *et al.*, 2005). For instance, Lee *et al.* (2009) found young people prefer light colours and elder people prefer dark colours; also, young adults preferred achromatic colours more than older adults (Ou *et al.*, 2012). Dittmar (2001) reported that colour preference tends to be stable for youths; however, blue colour preference starts to decrease, and green and red become more preferred when people enter old age. For example, in one study the preference for blue decreased with advancing age, whereas that for red increased (Wijk *et al.*, 1999).

2.4.3.5 Gender

Individual colour preference shows a significant difference between genders across almost all age levels (Franklin and Davies, 2006; Zhang *et al.*, 2019). For infants, there is no difference between genders; they all prefer warmer colours (Franklin and Davies, 2006; Teller *et al.*, 2004). However, for children, Burkitt *et al.* (2003) noted that girls prefer pink and boys much prefer light blue. For adults, generally, males prefer dark colours, while female prefer light colours (Zhang *et al.*, 2019). Ling *et al.* (2006) found that females prefer reddish colours than males, and male prefer bluish colours than female. He *et al.*, (2011) provided an explanation that males prefer calming colours such as blue and green to promote patience; however, females are attracted by food-related colours such as pink and purple. Another explanation suggested was that males prefer stimulating colours such as yellow to increase their sociability, while females prefer energetic and disturbing colours such as orange to increase their aggression-hostility (Zhang *et al.*, 2019).

2.4.3.6 Culture

Saito (1996) suggested that different cultural backgrounds lead to different individual colour preferences and that this should be taken into consideration in product design process (Ou *et al.*, 2012; Luo, 2005). Lots of studies have verified a culture difference by using a comparative method to compare the colour preference for countries (two or

more). For example, Yokosawa *et al.* (2010) found the high agreement with Child and Iwao (1969) results that the similarities in hue preference (liked blue and disliked dark-yellow) and differences in chroma and lightness (USA liked darker colours more than Japanese). Ou *et al.* (2003) found that UK prefers ‘cool’ colours, and Chinese prefer ‘clean’, ‘fresh’ and ‘modern’ colours.

The Chinese preference for red may be connected with the association of red as the colour of ‘good fortune’ in Chinese culture (Hurlbert and Ling, 2007). However, it has been found that Chinese participants do not like all forms of red, only like ‘Da Hong’ (means ‘big red’) in Chinese language (Zhang *et al.*, 2019). This red has been used in many important events such as weddings, older people’s birthday parties, and opening ceremonies of new companies, according to Chinese tradition up to now (Chen and Wang, 1965; Gunnerod, 1991). That suggested that the culture influence in individual colour preference may not only crossing the three colour dimensions, rather than for a specific meaning for a specific colour, such as the ‘Da Hong’ in Chinese. *Colour association* (in colour information we called *colour meaning* and *colour psychology*) is reviewed in the next section.

2.4.4 Colour association

The review of colour preference suggested that *colour preference* may be due to the affective response to the *colour meanings* that humans associate with the colours that they see. For example, blue with clear-sky and clean-water, browns with faeces and rotten food (Palmer and Schloss, 2010); or the emotional associations of colours, such as the more desirable emotions are associated with less preferred hues (Ou *et al.*, 2004); or the meaning of colours, such as ‘Da Hong’ means ‘good fortune’ which is highly preferred by Chinese (Zhang *et al.*, 2019). All of these concepts, however, suggest that *colour association* might be related to colour preference and may be important in product colour design.

Generally, colour association research has been implemented by presenting a physical

colour (Guilford and Smith, 1959), or a digital colour on a monitor (Chen *et al.*, 2020), or by providing a colour name which prompts the participant to imagine a colour; and then asking participants to provide their associations, or to match provided terms (Taylor *et al.*, 2013) etc. As a result, Bradford (1931) divided colour association responses into five groups: character, objective, emotional associations, physiological and sensational associative. Dorcus (1926) further divided them into eight groups, including natural objects (flowers); house furnishings (chair); dress and apparel (shoes); descriptive words (pretty); repulsive words (sickness); edibles (fruit); miscellaneous objects (sign); words of emotional content (love).

Even though it is evident that colour preference and colour association affect consumers' product colour preferences, there is no definitive theoretical explanation about exactly how colour association affects human perception or preference in product colour. To explore this gap, three types of colour association responses have been initially reviewed: colour association from objects, from mood, and from life experience.

2.4.4.1 Colour association from objects

Some studies have provided evidence that colour preference is dependent on the type of objects (Taft, 1997). For example, participants were asked to list objects that they associated with a colour. Average valence (like/dislike) ratings were measured for all object-names as associates of each colour. The preference measured the extent to which people like the set of objects associated with that colour. They found that preference for coloured objects causally influences corresponding colour preference (Palmer and Schloss, 2010). Moreover, colour preference may be changed by exposure to affectively biased samples of coloured-objects (Palmer and Schloss, 2012). Taylor and Franklin (2012) found that the colours associated with only few objects are more likely to be liked than colours associated with many objects. For example, in a chromatic environment, a colour associated with only a few objects could have a stronger object/colour identity and therefore might elicit a clearer internal image than a colour

associated with multiple objects. An example would be light blue being associated with sky but dark yellow being associated with ‘a lot of stuff’. That may suggest that there is a negative relationship between the number of objects and colour preference. One possible interpretation is that the colour is liked because it is associated with few objects.

2.4.4.2 *Colour association from mood*

Some studies have explored associations of colour and mood (Odbert *et al.*, 1942; Rogers, 1950). For example, cool colours have been associated with moods such as calm, serene, and comfortable, while warm colours have been associated with moods as stressful and exciting (Chen *et al.*, 2020). Wexner (1954) proposed a hypothesis that there is a positive relationship between certain colours and mood-tone, such as red is more often associated with exciting-stimulating, blue with secure-comfortable, orange with distressed-disturbed upset, blue with tender-soothing, purple with dignified-stately, yellow with cheerful-jovial-joyful, and black with powerful-strong-masterful. Researchers also noticed that some colours were more often chosen to go with certain groups of words describing the mood, such as red with exciting, orange with gay, yellow with playful, green with leisurely, blue with tender, purple with solemn, and black with sad (Feltman and Elliot, 2011; Farrelly *et al.*, 2013). Kam *et al.* (2021) found the colour of clothing worn had a significant effect on self-predicted shooting accuracy, especially when participants wear red bibs compared to blue and black bibs. It was suggested that wearing red enhances participants’ self-perception of dominance and aggressiveness, presumably generating a heightened self-perceived performance (Hill and Barton, 2005).

2.4.4.3 *Colour association from study or life-experience*

Jacobs *et al.* (1991) claimed that associations with colour may be influenced by studying and life-experience, including cultural learning, educational background etc (Demir, 2020; Chen *et al.*, 2020). For example, Schloss *et al.* (2011) provided evidence

that colour preference is influenced by a group's experience of objects or entities (for example Berkeley's and Stanford's students). Participants preferred their university identify colours over the other university's colours, and this effect was stronger the more they liked and identified with their university. One of the interesting applications is, the fan identity of 'red footballscape' in Manchester United. The supporters wear red whilst singing and chanting at the matches in the Old Trafford 'atmosphere' (Brown, 2007). When people are exposed to the same colour, their colour perception and hence the meanings and emotions may differ, such as for colour red, Chinese may associate red with 'good fortune', Manchester United fans may associate red with 'Red Devils' etc. This may suggest that for different products, consumer's associations may differ, especially if they have different cultural and life-experiences.

2.4.5 Summary for perception and preference

One of the ways to understand consumers' product-colour expectations is utilising knowledge of colour theory; additionally, attention needs to be given to colour preference and colour association research (Taft, 1997). The *research strategies* for colour preference and colour association have been reviewed including experimental samples, materials, environments and methods.

Lots of research has found that *colour preferences* are related to various factors such as gender (Mikellides, 2012; Dittmar, 2001), age (Teller *et al.*, 2004), cultural background (Eysenck, 1941; Satio, 1996) or life experience (Schloss *et al.*, 2011). Also, individual colour preference is highly connected with colour associations, such as object and emotion association, despite individuals surround different culture or life-experience (Zhang *et al.*, 2019). However, although some studies have demonstrated that product colour is very important in design (Rettie and Brewer, 2000), the content of colour preference and colour association is often overlooked, so the findings cannot broadly be applied to design. In other words, consumer personal colour perception and preference may also be important, but their role in purchase decisions is less clear. This

is discussed further in the following section.

2.5 Discussion for CHAPTER 2

Today, successful companies seem to engage with consumers by having a dialogue with them at an emotional level that resonates with their intrinsic needs. Thus, consumers make decisions emotionally and subsequently rationalise them logically (Kam *et al.*, 2021). Emotions facilitate decision making when logic and information are unavailable because emotions are utilised to influence the consumer's response to a product (Morrison and Crane, 2007; DeWitt *et al.*, 2008). However, product packaging works as a tool for differentiation that helps consumers to choose the product from wide range of similar products, stimulates customers buying behaviour, such as the visual element in the package, especially colour, influences consumers' perceptions for the benefits of products (Gumulya and Onggo, 2016). Moreover, product colour both contains a phenomenon and a medium of visual perception and communication (Luo, 2005). For example, product colour shapes human experience visually; also, it conveys meaning, emotional moods and functional information (Buether, 2014). However, the critical question is how to apply these emotions, information and behaviours into colour product design.

In this literature review, *colour theory* has been introduced to investigate the role of colour in consumers' purchase decisions in the context of product colour design (Luo, 2005). Colour preference and colour association research findings have been reviewed. For colour preference, there are significant differences between humans in terms of age, gender, and cultural or life experiences. Individual colour preferences are also influenced by colour associations, such as human physiologically factor (Hurlbert and Ling, 2007), objected-colour (Palmer and Schloss, 2012), emotion-mood (Ou *et al.*, 2004) etc. Furthermore, colours contain associations (such as emotions or objects etc.) for humans (Zhang *et al.*, 2019).

It could be argued that the role (or the extent) of *product-colour preference* may vary

between consumers; meanwhile, *product-colour associations* may also vary between consumers. It could be argued that colour preference and product colour preference are independent, and that *product categories* and *product-colour preference* are also independent. We can ask whether *colour preferences* or *colour associations* influence the product-colour decisions for the same product in *different situations*. Four critical views have been identified:

1. Even though consumer personal colour preferences are important in consumer purchase decisions, their exact role is less clear (Westland and Shin, 2015). It is worth *exploring* to what extent personal individual colour preference and personal colour association affects consumers' product-colour choice, and seeking to determine why this happens.
2. In some cases, the shopping conditions, for example, may drive consumer purchases differently. It is unclear whether consumer product-colour purchase decisions for each product would remain the same in various shopping conditions. It is worth *exploring* whether the various conditions or situations (length of shopping time, for example) affects consumers' product-colour choices and to *predict* what is likely to happen in different situations.
3. Taft (1996) reported comments such as 'I like green-colour, but you can't put it on a computer'; 'the colour just doesn't go with the chair'; and 'that is a very strange colour to be on this type of chair'. Although, colour preference is thought to be influenced by colour association and the associations (or meanings) that colour have may drive a consumer purchase for a product-colour, the relationship between colour association and product-colour association is unclear. It is critical to *explore* and *understand* the relationships between *colour preference*, *colour association*, the *decision-conditions (situations)* when consumers purchase a product of a particular colour;

4. Additionally, the research review presents a number of research strategies and methodologies for colour preference research. Personally, I am very interested in Monte Carlo methods and methodologies for colour preference research (Sanborn *et al.*, 2010). In this case, it is of value to *evaluate* how much agreement there is between individual colour preference results obtained from different research strategies and methodologies.

Based on these four critical views, five main research questions and fourteen sub-research questions have been identified. TABLE 2.5 lays out the details of the research questions for this research. To achieve this research, the *colour system*, *colour space*, *colour measurement and difference* have been employed as a scientific tool to locate and manage colours; the *colour preference* and *colour association* are used as an emotional scale tool to test colours in products. Research strategy and methodology details are introduced in CHAPTER 3.

TABLE 2.5 Main-research questions and sub-research questions for this research.

Main research questions	Sub-research questions
RQ 1: What extent that personal individual colour preference affects consumers' product-colour decision? (Chapter 4 Study 1)	RQ 1.1: Are there any other factors, which influence consumers' product-colour decision (except individual colour preference)? RQ 1.2: What is the relationship between individual colour preference and other factors when consumers purchase a product-colour?
RQ 2: Whether colour association influence consumers' product-colour decision? (Chapter 5, Study 2)	RQ 2.1: How many classifications of colour association consumers will provide when they see the colour squares? RQ 2.2: What are the reasons that consumers will provide when consumers purchase a colour of a product? RQ 2.3: What is the relationship between individual colour preference and colour association when consumers purchase a colour of a product?
RQ 3: Whether the length of shopping time affects consumers' product-colour	RQ 3.1: Whether the length of shopping time affects the stability of consumers' product-colour decision?

decision? (Chapter 6, Study 3)	RQ 3.2: What is the relationship between the product-colour consistency rate and the length of shopping time?
	RQ 3.3: Whether experimental sequence influence the research result in different time-length condition?
RQ 4: How much agreement are the results of individual colour preference from two research methods (6-alternative forced-choice and rank-order)? (Chapter 7, A Further-Analysis)	RQ 4.1: How much agreement are the results of individual colour preference from two research methods (6-alternative forced-choice and rank-order) and two research environments (online and laboratory)?
	RQ 4.2: Whether there are differences in individual colour preferences between different gender groups?
	RQ 4.3: Whether there are differences in individual colour preferences between different nationality (cultural) groups?
RQ 5: What are the relationships between colour preference, colour association, the length of shopping time and other factors when consumers purchase a colour of product between gender groups? (Chapter 7, A Further-Analysis)	RQ 5.1: Whether there are differences in Product-colour consistency between different gender groups?
	RQ 5.2: Whether there are differences in colour-associations and product-colour choosing reasons between different gender groups?
	RQ 5.3: Whether there are differences in product-colour decision-making time length between different gender groups?

3 CHAPTER THREE – RESEARCH DESIGN

‘While research designs involve making and reporting a range of choices about *what* is to be studied and *how* it will be studied, research proposals require much more emphasis on *why* the research is to be conducted, including *what* it will contribute to knowledge and/or practical outcomes, and *what* it has been designed in a particular way.’

-Blaikie and Priest (2018)

3.1 Introduction

‘Research design is an integrated statement of, and justification for, the technical decisions involved in planning a research project’ (Blaikie and Priest, 2018). Ideally, the research should be fully designed with a plan for data collection and analysis, before the research is carried out. Proper research planning achieves maximum control over the whole research process (Ackoff, 1953). Colloquially, a research design is a logical plan for how to get from ‘here’ to ‘there’, where ‘here’ is a set of initial questions to be explored, and ‘there’ are answers to these questions. Between ‘here’ and ‘there’ may be a number of methods and steps (Yin, 2003). However, the research design preparation may start with different elements and various procedures. However, the researchers always have choices and options for the process of research planning.

This chapter consists of five sections. Section 3.1 provides a brief introduction and summary of the chapter. Section 3.2 suggests a research design prototype for social research, outlining the research purpose and question, research strategy and methodology, research concepts and hypothesis, and data collection and analysis etc. Section 3.3 designs a detailed method for preparing experimental samples, and collecting and analysing the data. Section 3.4 provides an overview of the Research Design for the whole research. FIGURE 3.1 illustrates the detailed structure of this chapter.

2.1 Introduction					
2.2 Consumer Product- Colour Variety	2.2.1 Product packaging is a crucial element in consumer behaviour	2.2.2 The meaning of colour in product packaging	2.2.3 The application of colour in the design of product packaging	2.2.4 Summary for product colour	
2.3 Colour Theory	2.3.1 Colour ontology	2.3.2 A history of colour theory in Art, Science & Design	2.3.3 Colour description and communication	2.3.4 Colour information	2.3.5 Summary for colour theory
2.4 Understand colour perception and preference	2.4.1 Experimental method for colour preference research	2.4.2 General individual colour preference	2.4.3 Theoretical explanations and influential factors	2.4.4 Colour association	2.4.5 Summary for perception and preference
2.5 Discussion for CHAPTER 2					

FIGURE 3.1 The detailed structure of this chapter.

3.2 How to Design a Research

‘When designing social research, we needed to ask: given this research question (or theory), what type of evidence is needed to answer the question (or test the theory) in a convincing way?’ (De Vaus, 2001). In general, a research design needs to answer three basic questions: WHAT will be studied; WHY will it be studied; HOW will it be studied. The last of these could be further disassembled into five questions: WHAT logic inquiry will be used; WHAT ontological and epistemological assumptions will be adopted; WHERE will the data come from; HOW will the data be collected/generated and analysed; WHEN will each stage of the research be carried out? (Blaikie, 2003).

Designing research can be achieved in many ways. The following section introduces an overall example of what the structure of a research design may look like, including, research propose and research question, research logic, research strategy and concepts, theories and hypotheses research methodology, data analysis and data generation, a research problem and research limitation.

3.2.1 Research proposes and research questions

The definition of *research purpose* is a statement of ‘why’ the research is being carried

out (Harmon-Jones and Mills., 1999), and which types of knowledge will be produced (Blaikie, 2003). Research purposes are closely related to *research questions*. In many ways, *‘the formulation of research questions is the real starting-point in the preparation of a research design’* (Blaikie and Priest, 2018).

The list of *research purposes* should be considered at the very beginning of a research project. Technically, they specify what the research is intended to achieve, possibly including five basic research purposes (‘explore’, ‘describe’, ‘explain’, ‘understand’, ‘predict’) and three applied research purposes (‘change’, ‘evaluate’ or ‘assess impact’) (Blaikie, 2003).

On the other hand, research questions need to be stated clearly and concisely. This produces a particular type of knowledge defined by three types of questions, ‘what’, ‘why’ and ‘how’ (Blaikie and Priest, 2018). However, some researchers have proposed more than three types. Blaxter *et al.* (2010), for example, suggested five types of questions: ‘how’, ‘who’, ‘what’, ‘when’ and ‘why’. However, ‘who’ and ‘when’ questions are really ‘what’ questions; ‘what individuals’ and ‘at what time’. In general, ‘what’ questions seek descriptions, ‘why’ questions seek explanations or understandings, and ‘how’ questions are concerned with interventions. The order of these three types of research question for a research process could be: ‘what’ questions, followed by ‘why’ questions, followed by ‘how’ questions. TABLE 3.2.1 shows the types of research purposes and research questions for research design.

3.2.2 Research logic, research strategy and research methodology

An array of possibilities is available for answering research questions. The challenge for researchers is choosing appropriate research logic (or the approach) before the research starts. The research logic inquires a starting-point and a set of steps, which can be advanced using one, or a combination of, four logics: Inductive, Deductive, Retroductive and Abductive (Blaikie 2003). *Inductive* is to *describe* social characteristics and the nature of regularities, or networks of regularities in social life;

Deductive is to *explain* a theoretical argument for the existence of the social phenomenon under consideration; *Retroductive* is to discover underlying mechanisms to *explain* observed regularity; and, *Abductive* is to *describe* and *understand* social life (Blaikie and Priest, 2018).

The research methodology design also needs to undertake before the research begins. Blaikie (2003) suggested a work-flow including: to list a statement of motives and goals; to address the research questions that are associated with the research purposes; to elaborate the relevant concepts and theory appropriate for each research question; to propose a statement of the hypothesis or hypotheses to be investigated; to discuss the data selection methods and their sources, types and forms; to outline the data collection and/or generation, reduction and analysis methods; to discuss the ability to archive the research proposes and research questions, and any encountered problems and limitations. However, depending on the selected research logic and strategies, the research method may change slightly. TABLE 3.2.2 presents research logic, strategy and methodology for research design.

3.2.3 Concepts, theories and hypotheses

In design research, a concept is an idea that is expressed in words, commonly regarded as a building block of theories. A theory is an explanation of an observed pattern or regularity, the cause (or reason) needs to be understood. A discussion of concepts and theories is likely required in most research designs. It may occur in a ‘Conceptual Framework’ or a ‘Theoretical Model’ section (Blaikie and Priest, 2018). Perhaps, with the conceptual framework or theoretical model, some key concepts (or definitions) may need to be set out before the research process.

Hypotheses are tentative answers to research questions. They are usually stated in the form of a particular kind of relationship between two concepts, using the Deductive approach/logic (Blaikie and Priest, 2018). Mitchell and Jolley pointed out that ‘We do research to get answers to questions (Duck, 1993). Therefore, to do research, we must

TABLE 3.2.1. Types of research proposes and research questions (Blaikie and Priest, 2018).

Types of research purpose	Aims	Associated research questions
Exploratory	To <i>explore</i> is to attempt to develop an initial description or, possible, an understanding of some social phenomenon.	<i>What might be happening?</i> <i>What people are involved? In what way?</i>
Description	To <i>describe</i> is to provide a detailed account, or the precise measurement and reporting, of the characteristics of some population, group or phenomenon, including establishing regularities or patterns of association.	<i>What is happening?</i> <i>What are involved? In what way?</i>
Explanation	To <i>explain</i> is to establish the elements, factors or mechanisms that are responsible for producing the state of or regularities in a social phenomenon.	<i>Why is it happening?</i>
Understanding	To <i>understand</i> is to establish reasons for particular social action, the occurrence of an even or the course of a social episode, these reasons being derived from the ones given by social actors.	<i>Why is it happening?</i>
Prediction	To <i>predict</i> is to use some established understanding or explanation of a phenomenon to postulate certain outcomes under particular conditions.	<i>What is likely to happen?</i>
Change	To <i>change</i> is to intervene in a social situation by manipulating some aspects of it, or to assist the participants to do so, preferably on the basis of established understanding or explanation.	<i>How can it be made to be different?</i>
Evaluation	To <i>evaluated</i> is to monitor social intervention programmes to assess whether they have achieved their desired outcomes, and to assist with problem-solving and policy-making.	<i>What has happened? Why did it happen?</i>
Impact Assessment	To <i>assess social impacts</i> is to identify the likely consequences of planned projects, technological change or policy actions on social structures, social processes and/or people.	<i>What have been, or are likely to be, its individual social and environmental consequences? Why have these consequences occurred?</i>

TABLE 3.2.2 Research logic, strategy and methodology for research design (Blaikie, 2000; Blaikie and Priest, 2018).

Research logic	Aims	Kinds of research questions	Categories	Steps
Inductive	- To <i>describe</i> social characteristics and the nature of regularities, or networks of regularities in social life;	What Why	Quantitative	-Collecting data on characteristics and/or patterns. -Producing a description. -Relating laws to explain a further observation.
Deductive	- To <i>explain</i> a theoretical argument for the existence of the social phenomenon under consideration;	Why	Qualitative	-Identifying a regularity modelling explanation. -Constructing theories and deducing hypotheses. -Testing the hypotheses by matching them with data.
Retroductive	- To discover underlying mechanisms to <i>explain</i> observed regularity; To build on the premise that social reality consists of structures and internally related objects.	Why	Mixed	-Modelling regularity. -Constructing a context and a possible mechanism. -Establishing a mechanism provides the best explanation in that context.
Abductive	- To discover information from observing their activities and from the accounts they provide; To <i>describe</i> and <i>understand</i> social life (motives and accounts).	Mix	Mixed	-Discovering everyday lay concepts, meanings, and motives. -Producing a technical account from lay accounts. -Developing a theory.

start with a research question that can be answered. This question is usually start as a hypothesis – an idea, a prediction, capable of being disproven’. Lundberg (1942) provided a four-step process in ‘the scientific method’: formulation of research hypothesis; observation and recording of data; classification and organization of the data collection; and production of generations that apply under given conditions. This provides a classical role of ‘hypotheses’ in research design, which requires the researcher to have a guess (or prediction) about what the data might reveal, and then to proceed to see if it is, indeed, the case.

3.2.4 Data form, data collection and data analysis

Data collection and analysis are frequently regarded as the core activities in social research. Also, it is useful to consider in what forms data are required before the data collection and analysis method in order to answer the research questions. Broadly, data exist in two main forms, *numbers* and *words* (*quantitative* and *qualitative*). Even if the data begins as sound or as an image, at some point it will be transferred either to words or numbers, or perhaps to both. Data may collect (or remain) in one of these forms throughout the research process; however, it may be transferred from one form to another at some stage. For example, qualitative data from a questionnaire or interview, may be manipulated into numbers, prior to numerical analysis, and then interpreted in words (Blaikie and Priest, 2018). In other words, research can use both data forms, and may combine them in a variety of ways.

A wide range of quantitative and qualitative data collection methods are available including,

1. *Observation*, containing from highly-structured to under-structured and from very detached to very involved;
2. *Interviewing*, ranging from highly-structured to under-structured or in-depth methods within both individual and group interviews;

3. *Questionnaire*, including pen-paper and other electric forms;
4. *Content analysis*, such as secondary sources of many kinds (Pawson, 1995; Foddy, 1993).

The critical elements of quantitative data collection are whether a measuring test (or instrument) need to be developed (such as an attitude scale etc.) and whether the pre-testing and piloting process needs to be outlined and justified in advance; for qualitative data collection, the date of generation and recording method is important in addition to stating the reason why it is most appropriate (Blaikie, 2003). The other critical element is *the time(s)*. Sometimes the research is cross-sectional or longitudinal, retrospective or prospective, or historical. Thus, the researcher also needs to consider data collection in different times or frequencies (Blaikie and Priest, 2018).

Data reduction is the final core element of data analysis in a research design. Data reduction may involve transforming qualitative data into different categories, or combining/reordering categories. In studies that deal with large quantitative textual data, manipulation could start by generating categories or coded segments (as in grounded theory) (Jick, 1979); or in an abstraction language from lay language (as Giddens's use of Abductive logic) (Gidden, 1987). In both of these, analyses can include simple counting; for example, the numbers of responses are located in each of a set of ideal types.

3.2.5 Research problem and research limitation

Standing back and evaluating the research problems and research limitations is an important step for research design both in preparation and in the final stages. In the preparation stage, first of all, it is useful to state research/experimental problems that are likely to be encountered, and how they will be handled. The problems include both practical and theoretical problems; for example, getting cooperation with participants and respondents, or predicting further tests or case studies will be required after. In the

finish stage, the evaluation also is a good idea to make an explicit assessment of particular strengths and weakness of research design.

3.3 Adopting a Research Design in this Thesis

In this section, a logical plan with a set of research elements following an adopted research sequence is presented. The section lays out the research purposes and research question, an overall framework and hypothesis, and a brief plan of research strategies and research methodologies for the whole work.

3.3.1 Research proposes and research question for this thesis

According to the critical review of the literature (CHAPTER 2), four basic research purposes have been identified:

1. To *explore* to what extent personal individual colour preference and personal colour association affects consumers' product-colour choice, and to *explain* why it happens;
2. To *explore* whether the length of shopping time affects consumers' product-colour choice and to *predict* what is likely to happen in different situations;
3. To *explore* and *understand* the relationships between colour preference, colour association, the length of shopping time and other factors when consumers purchase a colour of product;
4. To *evaluate* how much agreement are the results of individual colour preference from different research methods.

Based on these four research purposes five main research questions and fourteen sub-research questions have been identified. TABLE 2.5 lays out the details of the research questions for this research (CHAPTER 2, Section 2.5).

3.3.2 Research strategies and research methodologies for this thesis

On the basis of that a sum of exploration, explanation, understanding, prediction and

evaluation research purposes and research questions have been proposed, an *abductive* research strategy has been primarily chosen for the research. *Deductive* and *inductive* strategies have also been employed specifically to test or build theories for several of the sub-research questions. Both quantitative and qualitative research methods have been used to collect quantitative and qualitative data. The research questions for this study (TABLE 2.5) are ‘Whether’ (RQ.1 and RQ.3), ‘What’ (RQ. 2 and RQ.5) and ‘How’ (RQ.4) questions. TABLE 3.3.2 lays out the research plan (including research purposes, research strategies, research methodologies and research activities) for this thesis.

TABLE 3.3.2 The research strategies and research methodologies for this thesis.

Types of purpose	Kinds of research question	Types of strategy	Categories	Aim	Research activities (Steps)
Exploration	Whether	Inductive	Quantitative	-To explore whether personal general colour preference affects consumers’ product-colour decisions.	Online Surveys + Laboratory Experiments
				-To explore whether the length of shopping time affects consumers’ product-colour decisions?	
Explanation Understanding	What	Deductive	Qualitative	-To explain the colour association consumers will provide when they see the colour squares, and the reasons that consumers will provide when consumers purchase a colour of a product.	Interviews
				-To understand the relationship between colour associations and product-colour choosing reasons	
Prediction Evaluation	How	Abductive	Quantitative + Qualitative	-To describe and understand whether personal general colour preference affects consumers’ product-colour decisions.	Online Surveys + Laboratory Experiments + Interviews
				- To how much agreement are the results of individual colour preference from different research methods	

3.3.3 Development of frameworks and hypothesis

Eight research activities (three online surveys, four laboratory experiments and an interview) have been applied in separate studies: Study I (CHAPTER 4), Study II (CHAPTER 5), Study III (CHAPTER 6) and Further Analyses (CHAPTER 7).

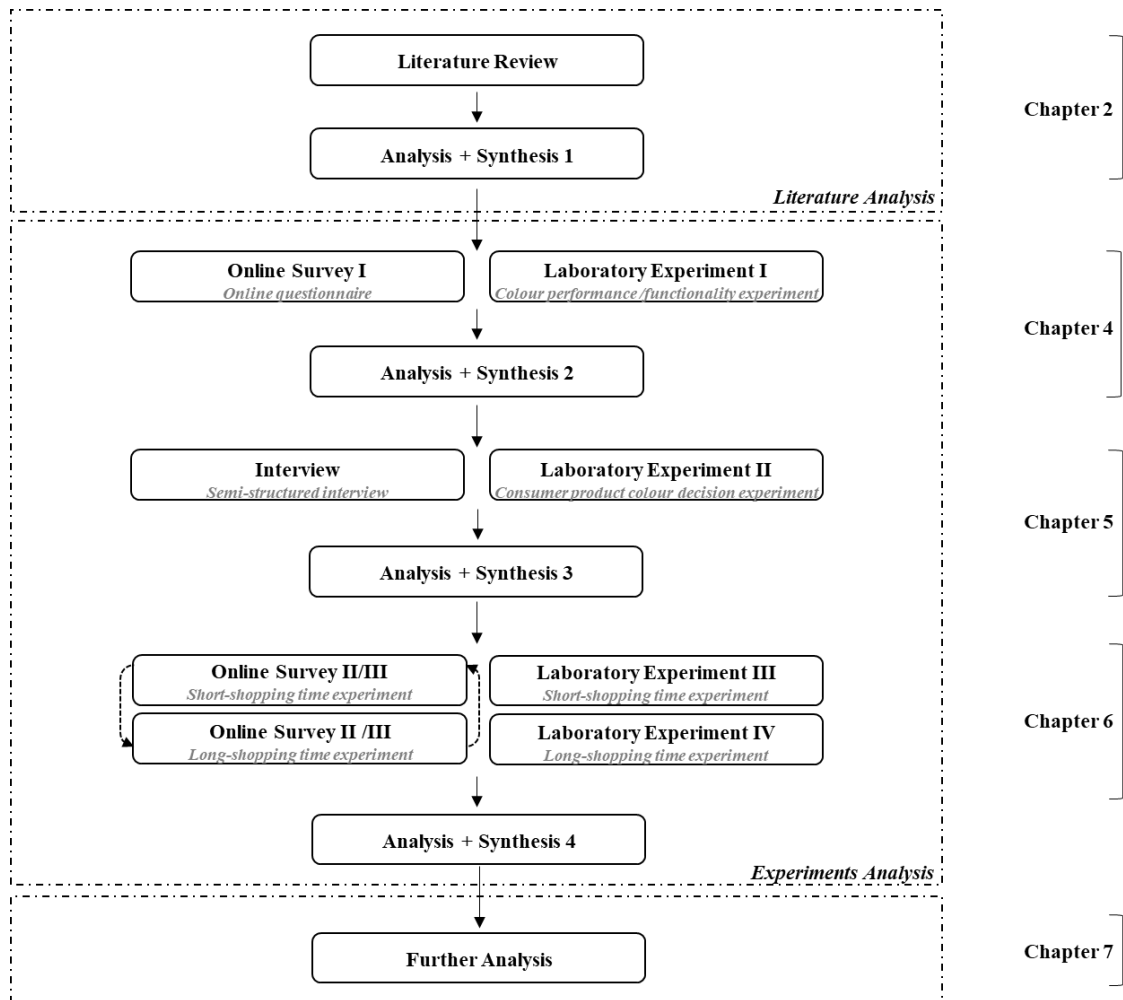


FIGURE 3.3.3 Development of a brief framework for the research.

Four frameworks (for each experimental chapter) were developed to test the three hypotheses (details are described in relevant chapters). FIGURE 3.2.3 illustrates a brief description of research strategies, the research activities and the relevant chapters. The research hypotheses will detail in the relevant chapters.

3.3.4 Concepts used for frameworks

Six concepts are introduced in frameworks for each of the chapters: Individual Colour Preference, Product-Colour Purchase Decision, Colour Functionality, Colour Performance, Colour Culture and Colour Association as the primary factors in consumers' product-colour purchase decisions; Decision Time-length works as an influential element on the factors (details are described in relevant chapters). Other definitions were introduced in the explanation part of the results: Product-Colour Consistency Rate, Popular Product-Colour, Product-Colour Association Score and Product-Colour Stability Rate. TABLE 3.3.4 introduces the definitions used in this research and relevant chapters.

TABLE 3.3.4 The concepts used for this research.

Concepts	Explanations	Chapter
<i>Individual Colour Preference</i> (Framework)	Individual colour preference is concerned with which colours individuals prefer among alternatives	4/5/6/7
<i>Product-Colour Purchase Decision</i> (Framework)	The product-colour purchase decision is the colour participant choose for that product.	4/5/6/7
<i>Colour Functionality</i> (Framework)	Colour functionality relates to whether a colour is appropriate for the function of the product.	4
<i>Colour Performance</i> (Framework)	Colour performance is where the consumer might infer that a product works better when it is one colour rather than another.	4
<i>Colour Culture</i> (Framework)	Colour culture relates to where it is culturally important that a product is a particular colour.	4
<i>Colour Association</i> (Framework)	Colour association relates to whether a colour is appropriate (in terms of association/information) for the product.	5
<i>Decision Time-Length</i> (Framework)	The length of shopping time.	6/7
<i>Product-Colour Consistency Rate</i> (Results)	The extent to which the chosen product colour matches the personal colour preference is calculated as a per cent figure and this will be referred to as the colour consistency rate.	4/5/6/7

<i>Popular Product-Colour</i> (Results)	Products for which more than 40% of participants selected the same colour (this threshold is somewhat arbitrary but is more than double the value we would expect if participants made random colour choices).	4
<i>Product-Colour</i> <i>Performance/Functionality</i> <i>Scores</i> (Results)	For each product, the extent to which participants think colour could be related to functionality or performance.	4
<i>Product-Colour</i> <i>Association Score</i> (Results)	The extent to which the product-colour decision reason matches the colour-patch associations is calculated as a per cent figure (weight percentage) and this will be referred to as the product-colour association score.	5/7
<i>Product-Colour Stability</i> <i>Rate</i> (Results)	The extent to which the chosen product-colour from Laboratory Experiment IV matches the chosen product-colour from Laboratory Experiment III is calculated as a per cent figure; recall, this is referred to as the product-colour stability rate.	6/7

3.4 Experimental Methods and Configuration

In this section, before the research experiments undertake, the experimental methods and configuration need to be planned. It consists of sample preparation (colour patches and product-image samples), the data collection method, participant recruitment and the experimental procedure, data analysis, and review the problems and research limitations may occur in research.

3.4.1 Experimental sample preparation

The experimental sample preparation consists of the selection of colour patches, product categories selection and product experimental-images production.

3.4.1.1 Selection of colour stimuli

In this study, six colour patches (red, orange, yellow, green, blue and purple) were

selected from an Adobe HSB colour system (Camgöz *et al.*, 2002). The colours were chosen to have almost identical brightness and saturation so that the only variable was hue (in this research hue is the only colour variable considered although in principle the work could be extended to include lightness and chroma). This colour strategy is used in Study I (CHAPTER 4), Study II (CHAPTER 5), Study III (CHAPTER 6) and Meta-Analysis (CHAPTER 7).

The display was colour calibrated; however, coloured patches were defined by sRGB values and the actual colours that were displayed on the monitor were measured using a Minolta CS100A colorimeter and these are reported in TABLE 3.4.4.1 for the colour squares by using CIE Yxy, CIE L*a*b* and CIE L*C*h values.

TABLE 3.4.4.1 The sRGB, CIE Yxy, CIE L*a*b* and CIE L*C*h colour coordinates of the six basic colour squares.

Colour coordinates of the six basic colour squares						
Coloured Squares	Red 	Orange 	Yellow 	Green 	Blue 	Purple 
sRGB	255, 0, 0	255, 127, 0	255, 255, 0	0, 255, 0	0, 0, 255	127, 0, 255
CIE Yxy	53.50, 0.64, 0.34	86.90, 0.56, 0.40	210.00, 0.44, 0.49	155.00, 0.32, 0.59	11.60, 0.14, 0.04	28.60, 0.21, 0.09
CIE L*a*b*	40.01, 55.08, 58.27	49.84, 28.88, 64.20	72.35, -17.18, 80.75	63.85, -68.14, 69.37	17.65, 75.93, -89.76	29.46, 61.16, -63.54
CIE L*C*h	40.01, 80.19, 46.61	49.84, 70.39, 65.77	72.35, 82.56, 102.20	63.85, 97.24, 134.49	7.65, 117.57, 301.23	29.46, 88.19, 313.91

3.4.1.2 Selection of product

In Study I (CHAPTER 4), 54 products were selected (see CHAPTER 4.3.1) all of which were household, kitchen and bathroom products which are typically used every day. Product category samples were extracted from the homepage of ASDA Groceries. At the first stage, only commodities such as household supplies and health items have been considered (although the research could be extended to other categories). One or two original samples were chosen from each category. In Study II (CHAPTER 5), 51 products were selected (see TABLE 5.3.1) and the product categories were expanded from Study I (clothes and food products were added). In Study III (CHAPTER 6), 20 products were selected (see TABLE 6.3.1) from Study II (details had been explained in

section 6.3.1). TABLE 3.4.1.2 summaries the product selection strategies that were used in this research.

TABLE 3.4.1.2 Product-selection strategy used in this thesis, including product categories number, product types and relevant chapters.

The product-selection strategy used in this thesis			
Study (Chapter)	Product number	Product types	Name lists
Study I (CHAPTER 4)	N=54	Kitchen, Bathroom, Personal-care products	TABLE 4.3.1
Study II (CHAPTER 5)	N=51	Kitchen, Bathroom, Personal-care, Clothes, Food products	TABLE 5.3.1
Study III (CHAPTER 6)	N=20	Kitchen, Bathroom, Personal-care, Clothes, Food products	TABLE 6.3.1

3.4.1.3 Experimental sample procedural

Each of the products was digitally manipulated in Adobe Photoshop to create images in each of six colours (red, orange, yellow, green, blue and purple). FIGURE 3.4.1.3 shows the coloured images for two of the products (for illustration) and also the six colour patches that were used to determine participant individual colour preferences. Appendix C.1, Appendix D.1 and Appendix E.1 show the full coloured images for all the products used (details are described in relevant chapters).

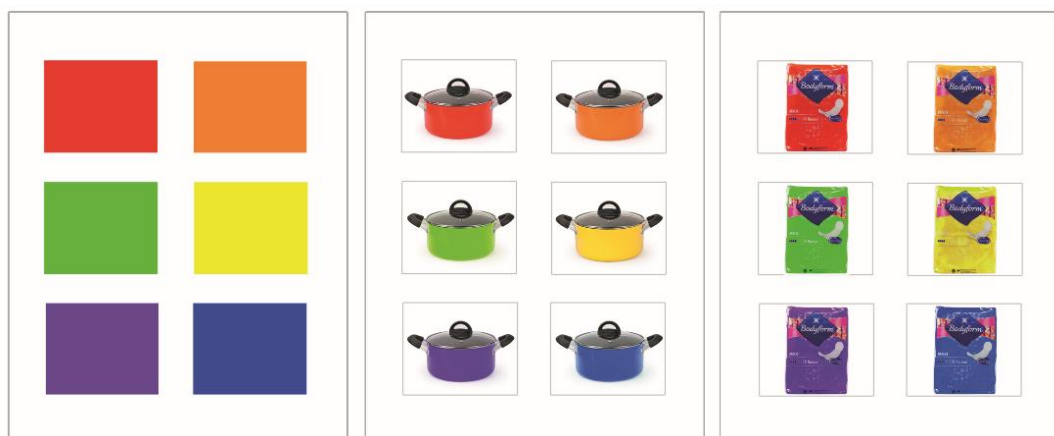


FIGURE 3.4.1.3 The coloured images for two of the products in each of the six colour options and the six colour patches that were used to determine colour preference.

3.4.2 Data collection

As the research proceeded, different research methods were applied in separate research phases to meet each research objective. Three online surveys, an interview and several laboratory experiments were employed to collect data. One online survey was designed to test whether personal general colour preference affects consumers' product-colour purchase decision and to set up the hypotheses for subsequent experiments (RQ 1). The interview (semi-structured) was conducted to investigate the types of colour associations from consumers and to explore the reasons why consumers would purchase a particular colour of a product (RQ 2). Laboratory experiments and other two online surveys were established to provide quantitative data to evaluate formulation hypotheses (RQ 1, 3, 4 and 5). TABLE 3.4.2 illustrates the data collection methods adopted for this research.

TABLE 3.4.2 Data collection methods adopted for this research (the N indicates the number of participants).

Methods used	Description
Online Surveys (CHAPTER 4,6)	Consumers (worldwide): Online Survey I, N=173; Online Survey II, N=20; Online Survey III, N=21).
Laboratory experiments (CHAPTER 4, 5, 6)	Consumers from the University of Leeds took part in: (Laboratory experiment I, N=39; Laboratory experiment II N=37; Laboratory experiment III, N=24; Laboratory experiment IV, N=24).
Interview (CHAPTER 5)	Consumers from the University of Leeds were interviewed in person (N=37).

In Chapter 4, Online Survey I and Laboratory Experiment I recruited 173 consumers worldwide (comprising of 62 males and 111 females, and 49 UK and 73 Chinese) and 39 participants from University of Leeds (including 18 males and 21 females, and 14 UK and 19 Chinese). In Chapter 5, 37 participants were recruited to take part in Interview and Laboratory Experiment II (comprising of 18 males and 19 females), all

participants were students or staff at the University of Leeds. In Chapter 6, Laboratory experiment III and Laboratory experiment IV recruited 24 Master and PhD students as participants from University of Leeds (including 12 males and 22 females), and Online Survey II and Online Survey III were recruited 41 participants (including 20 males and 21 females). The procedures are described in detail in the relevant chapters.

3.4.3 Data analysis

A template approach was employed for coding and clustering qualitative data (King, 2012). R-squared is the coefficient of determination and is the square of the correlation coefficient. It is a statistical measure of well a set of data are fitted by a regression line. Specifically, it denotes the proportion of variation accounted for in the data by the linear model; if $r^2 = 1$ then the data are perfectly fitted by the linear model. R-Squared Test and Person Correlations Test tests were recruited to test the relationship between personal colour preference and product's colour choice. Paired-Sample T-Test, Independent T-Test and Stability Test were used to explore the relationship between timing variables and the stability/reliability for each participant. Monte Carlo Analysis and Independent Chi-Squared were used to comparing stability for the colour preference results from two research methods. Template Analysis was used to analyse qualitative data from interviews, and classify colour associations and product-colour decision reasons. Descriptive and inferential analysis were used for analysing quantitative data, additionally, the Kappa Coefficient dyadic comparison was used to compare the similarities and differences between how individuals code in this research. Data analysis procedures are described in detail in the relevant chapters. TABLE 3.4.3 includes a brief description of the methods used for data collection, participants' details and the relevant chapters.

TABLE 3.4.3 Data analysis methods adopted for this research.

Methods used	Purposes
--------------	----------

Descriptive Statistic (CHAPTER 4, 5, 6)	-To identify the universal colour preference. -To explore whether consumers' product-colour decisions are affected by colour preference, colour association, the length of shopping time and other factors.
Chi-Squared Test for Independence (CHAPTER 4, 7)	-To test the agreement of the results of colour preference from an online survey and several laboratory experiments. -To test the agreement of the results of colour preference from different gender and nationality groups.
R-Squared (CHAPTER 4, 5, 6, 7)	-To test the correlation for the product-colour consistency rate from experiments. -To identify the agreement for colour preference from two research methods (6-alternative forced-choice and rank-order).
Template Analysis (CHAPTER 5, 7)	-To analyse qualitative data from interviews.
Kappa Reliability Testing (CHAPTER 5)	-To test similarities and differences between how individuals code in the same research.
Pearson Correlation Test (CHAPTER 6)	- To identify the relationship between the length of decision-making time and product-colour consistency rate.
Paired-Sample T-Test (CHAPTER 6)	- To investigate whether the length of decision-making time affects the stability of consumers' product colour decision?
Stability Test (CHAPTER 6, 7)	- To identify whether there are differences in product-colour decision-making time length.
Independent T-Test (CHAPTER 7)	-To compare the product-colour consistency for male and female conditions.
Monte Carlo Analysis (CHAPTER 7)	-To compare the results of colour preference from two research methods (6-alternative forced-choice and rank-order).

3.4.4 Research problem and limitation may occur in this thesis

Most research projects have some problems and/or limitations. Lack of awareness of both strengths and weaknesses of a research design could result in a shallow understanding of the research. In this work, colour measurement and experimental sequence (for repeating experiments) need to be considered before the experiments are conducted.

3.4.4.1 Colour measurement

Frist of all, colours of the products were modified in Adobe Photoshop to be a visual match to the intended colours. However, this visual-matching process introduced a small amount of error. For the purposes of this work very high colour fidelity of the colours on the display was not necessary but it was important that observers would recognise the products as being categorically either red, yellow, or green etc. FIGURE 3.4.4.1 (a) reports the actual measured colours (using a Minolta CS100A colorimeter) from some of objects from Study I (CHAPTER 4) for illustration (Opener, Water maker, Table Cleaner, Soap Bar, Mouthwash, Tissue, Coffee Maker, Toner, Sanitary Towel, and Iron Casserole Pot) that were displayed on the monitor. The ΔE is the average ΔE between the product colour and the appropriate squares colour (equations see Section 2.3.3). The purpose of FIGURE 3.4.4.1 (b) is to communicate to the reader the level of variability of colour that was inherent in the experiment. Note that there is some noticeable variation in the colours of the objects but that the different colour names are still always distinct and easily recognisable. FIGURE 3.4.4.1 represents visually the extent of the variability that occurred between the products. The CIELAB colour coordinates and the colour variability images for Study II and Study III have been shown in Appendix B.1 and Appendix B.2.

Colour variability																		
Coloured-objects	Red			Orange			Yellow			Green			Blue			Purple		
	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*
Opener	39.05	51.81	58.11	50.49	24.40	66.52	69.30	-13.06	77.63	64.02	-64.86	69.50	21.53	77.38	-86.10	24.75	57.95	-57.77
Water Maker	38.50	51.43	49.12	46.07	29.28	56.71	69.46	-13.87	76.72	62.27	-59.46	69.85	16.86	78.33	-86.80	24.95	61.08	-58.95
Table Cleaner	40.25	55.49	60.25	50.61	24.49	63.02	70.20	-14.53	76.69	62.09	-63.48	68.93	19.57	55.55	-73.95	28.21	70.13	-72.03
Soap Bar	36.16	49.77	46.31	44.43	34.20	58.60	71.36	-8.09	84.00	66.18	-63.09	68.30	25.59	64.94	-80.99	31.09	63.63	-65.02
Mouthwash	37.18	50.12	51.84	48.71	22.15	63.27	67.30	-16.77	74.02	59.69	-64.70	64.49	23.03	77.17	-87.32	27.52	68.18	-66.82
Tissue	35.30	49.58	49.75	47.38	27.51	60.29	67.77	-3.25	76.87	65.86	-69.54	70.53	21.38	53.10	-68.17	24.75	63.83	-62.56
Coffee Maker	37.95	50.80	50.38	47.13	26.09	53.87	68.70	-16.26	69.78	63.16	-64.45	68.50	26.82	64.59	-86.99	30.75	59.02	-58.83
Toner	36.40	50.77	50.20	46.88	33.91	60.34	69.60	-11.48	71.00	63.85	-66.78	68.44	17.55	66.91	-82.12	29.30	69.53	-70.64
Sanitary Towel	37.91	52.25	52.84	44.94	28.29	58.16	67.93	-12.61	75.99	67.62	-72.44	72.17	19.91	52.57	-72.21	24.21	63.10	-67.28
Iron Casserole Pot	40.08	52.54	53.94	49.02	28.04	61.50	68.08	-14.86	69.46	65.03	-65.22	74.43	18.41	44.88	-72.57	31.19	58.82	-63.04
ΔE	7.94			6.80			9.40			5.06			16.71			6.98		

FIGURE 3.4.4.1 (a) The CIELAB colour coordinates for 10 of the products in each of the six basic colours in order to demonstrate the extent of the variability. The ΔE is

the average ΔE between the product colour and the appropriate patch colour in Table 3.4.4.1.

Colour Variability										
Coloured-objects	Opener	Water Maker	Table Cleaner	Soap Bar	Mouthwash	Tissue	Coffee Maker	Toner	Sanitary Towel	Iron Casserole Pot
Red										
Orange										
Yellow										
Green										
Blue										
Purple										

FIGURE 3.4.4.1 (b) The coloured images for two of the products in each of the six colour options and the six colour patches that were used to determine colour preference

3.4.4.2 Experimental sequence

Study III explores whether the length of shopping time affects consumers' product-colour decisions. Thus, personal product-colour choices measured for each product conduct with different decision-time conditions. In order to eliminate the decision-time condition experimental sequence element, two online surveys are introduced to have a 'sequence element' pre-test. The details will represent in relevant CHAPTER 6.

3.5 Overview of Research Design

An abductive approach was mainly chosen for this exploration research, but combined with some deductive and inductive approaches. FIGURE 3.3.3 provides an illustration of the research activities and general level. TABLE 3.5 provides an overview of research activities. Each data collection and analysis methods applied in this research would be discussed detail in CHAPTER2, 4, 5, 6 and 7.

TABLE 3.5 Overview of the research methodology.

Research activities	Data collection	Data analysis	Objectives	Chapter
Literature analysis	Secondary resources	Qualitative Analysis	-To identify the research questions.	2
Online questionnaire	Online survey I	Descriptive Statistic R-Square	-To test the individual colour preference; -To explore whether consumers' product colour decision affects by individual colour preference. -To investigate that is there any other factors, which influence consumers' product-colour decision (except colour preference);	4
Colour performance /functionality experiment	Laboratory experiment I	Independent Chi-Square Test	-To identify the relationship between the individual colour preference factors and product-colour functionality/performance factors;	
Interview	Semi-structured interview	Template Analysis	-To analyse the classifications of colour association consumers will provide when they see the colour squares;	5
Consumer product colour decision experiment	Laboratory experiment II	Descriptive Statistic Independent Chi-Square Test	-To test whether colour association influence consumers' product colour decision; -To select products for Study III;	
Short-shopping time experiment	Laboratory experiment III/IV +	Descriptive Statistic Independent Chi-Square Test	-To test the stability of each participant who gave two times answer for and Study III;	6
Long-shopping time experiment	Online survey II/III	Paired-sample T-Test Stability Test	-To identify whether there were significant differences product colour choosing results between long time and short time shopping;	
Results evaluation	Experiment's review	Descriptive Statistic R-Square Test Chi-Squared Test for Independence Independent T-Test Template Analysis Stability Test Monte Carlo Analysis	-To test the agreement of the results of colour preference from different research strategies; - To identify whether there are differences in individual colour preferences between different gender and nationality groups; -To explore whether there are differences in product-colour decisions between different gender groups.	7

4 CHAPTER FOUR – STUDY I: THE ROLE OF COLOUR PREFERENCE ON CONSUMERS’ PURCHASING BEHAVIOUR

‘Hypotheses also have a role when Abductive logic is used, and in grounded theory. However, their used here is less formal and is an integral part of the process of generating theory from data. Questions will arise from the analysis of some of the data, and hypotheses may be used to explore these questions, within the same body of data, or to stimulate further data collection.’

-Blaikie and Priest (2018)

4.1 Introduction

CHAPTER 2 suggests that the visual elements of a product, or even its packaging, potentially affect consumer purchase decisions as they provide an attractive and convenient method to convey messages about product attributes (Khouw, 2002). Craciun (2020) identified four major elements that integrate all relevant characteristics into a visual structure; moreover, colour is the most important one. Indeed, colour is one of the most important elements of visual merchandising and can influence consumer behaviour and consumer purchase decisions (Shagal *et al*, 2016; Ahmed Javed and Javed, 2015). Furthermore, individual colour preference may be one of the product-colour elements that are considered when they make a product-colour decision. However, it is also noted out that the effects of colour on product-colour choices may be different for different product categories (Miller, 2005; Westland and Shin, 2015). Critically, Study I is to *explore* to what extent personal individual colour preference affects consumers’ product-colour choices. Strictly, the work is about intended purchase decisions which may or may not translate into actual consumer purchases.

Following the research design in CHAPTER 3, this work employs two research activities (an online survey and a laboratory experiment) with visual components to investigate which colour a participant would choose if asked to select a product to purchase when there is a range of colours available. These two activities were also designed to elicit a response about which colour each participant prefers (this is colour preference, in an abstract sense). This work presents new experimental data about the role of colour in product and product packaging on intended consumer-purchase decisions. A conceptual framework (this framework is described in the next section), supported by the experimental findings, captures the relationship between individual colour preferences and product-colour choices, and more functional aspects of colour itself (such as the relationship between product colour and expected product performance or functionality). This framework will be used to explain and understand why individual colour preferences seem to matter for some product categories but not for others.

This chapter consists of six sections. Section 4.1 summarises the achievement of this chapter. Section 4.2 presents the research design for this work. Section 4.3 outlines the experimental configuration for this study. Section 4.4 displays the key findings according to the research questions. Section 4.5 reflects upon the results and critiques the research methods before outlining the next steps for the research.



FIGURE 4.1 Structure for CHAPTER 4.

4.2 Research Design for Study I

The research design for this work consists of research questions, research strategies, research activities, research hypotheses and a framework.

4.2.1 Research questions, strategies and activities for Study I

In this study, one main research question (RQ 1) and two sub-research questions (RQ 1.1 and RQ 1.2) were translated into the research purpose for this chapter: 1) to *explore* whether, and to what extent, individual colour preference affects consumers' product-colour choice in all product categories; 2) to *understand* why colour preference seems to matter for some product categories but not for others and to *explore* other factors that might influence consumers' product-colour choices; 3) to *explore/explain* the relationships between individual colour preference, and other factors (these factors are described in the next section) when consumers purchase a product of a particular colour. Due to the *explore/understand/explain* nature of the research purposes, an *Abductive* research strategy has been chosen to collect *Quantitative* type data. An online survey (Online Survey I) and a laboratory experiment (Laboratory Experiment I) has been conducted (details see TABLE 4.2.1).

TABLE 4.2.1 Research questions, strategies and activities for Study I.

Research Question	Purpose	Research Strategy	Research Activity
RQ 1: What extent that personal individual colour preference affects consumers' product-colour decision?	-To <i>explore</i> whether individual colour preference affects consumers' product-colour choice in all product categories, and <i>explore</i> in what extent?	Abductive Strategy (Quantitative Data Type)	An Online Survey (Online Survey I) +
RQ 1.1: Are there any other factors, which influence consumers' product-colour decision (except individual colour preference)?	-To <i>understand</i> why colour preference seems to matter for some product categories but not for others; and to <i>explore</i> other factors might influence consumers' product-colour choices?		A Laboratory Experiment (Laboratory Experiment I)

RQ 1.2: What is the relationship between individual colour preference and other factors when consumers purchase a product-colour?	-To <i>explore/explain</i> the relationships between individual colour preference and other factors (these factors are described in the next section) when consumers purchase a product of a particular colour.
---	---

4.2.2 Research hypotheses and framework

In the framework illustrated in FIGURE 4.2.2, primary factors include *colour functionality*, *colour performance*, and *colour culture* (for definitions see TABLE 3.3.4). *Colour functionality* relates to whether a colour is appropriate for the function of the product. For example, red might be appropriate for a toaster because a toaster is hot. Nature and gardening products are often green to relate to nature and environmental friendliness (Pancer *et al.*, 2017) and televisions with black or silver are suggestive of technology (Page, 2012). However, for colour functionality, the colour does not usually make any difference to the performance of the product itself but rather is simply functionally appropriate. *Colour performance*, on the other hand, is where the consumer might infer that a product works better when it is one colour rather than another. An example would be that a consumer might infer something about the efficacy of a mouthwash based upon its colour. Or a consumer might infer that a dark colour washing up liquid might have greater efficacy than a light one. In some cases, the consumer inference is not correct but nevertheless can be a primary factor that drives a consumer purchase. Other factors such as *colour culture* relates to where it is culturally important that a product is a particular colour. For example, a bride may choose a white wedding dress; in some countries brides traditionally wear white even though some individuals may have strong individual preferences for other colours in an abstract sense. Whenever any of these primary factors are present it is suggested that individual colour preferences make little or no impact on consumer-purchase decisions. This could explain why in some studies it has been found that a relatively narrow range of colours

is preferred for some products (Kojina *et al.*, 1986; Westland and Shin, 2015) whereas other products are frequently found (and preferred by consumers) in a very wide range of colours (such as the Apple iPod nano). Previously published data (Westland and Shin, 2015) do, therefore, seem to support this new conceptual framework. However, that study was based on only 7 products and no data were actually collected regarding the primary factors illustrated in FIGURE 4.2.2 The study described in this chapter collects data for a large number of products and explicitly tests the hypothesis that colour may be an important factor in the absence of primary colour factors.

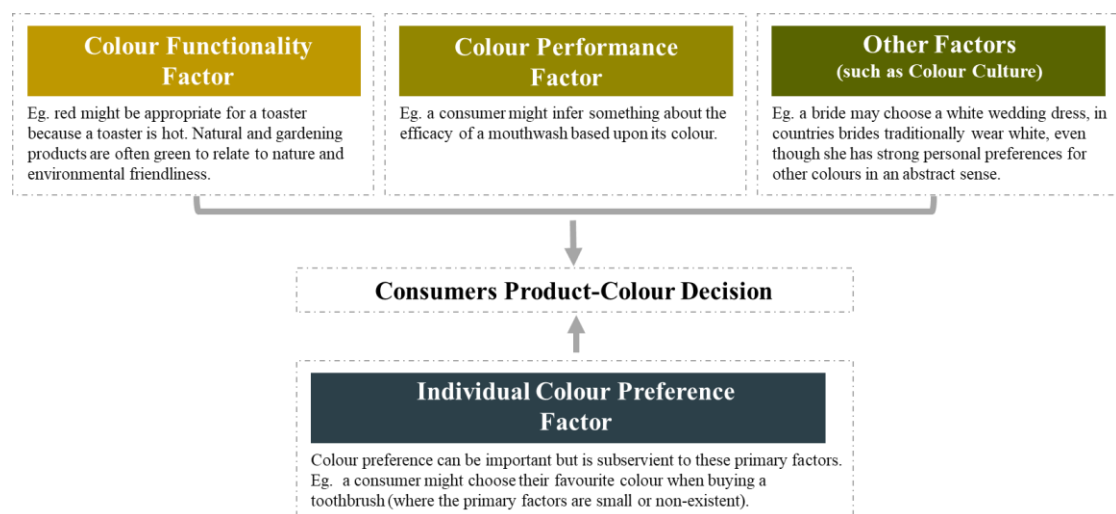


FIGURE 4.2.2 Framework for Study I.

4.3 Experimental Configuration

The experimental configuration consists of sample preparation (colour patches and product-image samples), the data collection method, participant recruitment and the experimental procedure, and data analysis.

4.3.1 Experimental samples preparation

In this study, 54 product categories were selected (see TABLE 4.3.1) all of which were household, kitchen and bathroom products, which are typically used every day. Six colour squares were used to determine participant individual colour preferences (see Section 3.4.1.1). Each of the products was digitally manipulated in Adobe Photoshop

to create images in each of the six colours (red, orange, yellow, green, blue and purple). Appendix C.1 shows the coloured images for all 54 products. The CIELAB colour coordinates and the colour variability images for Study 1 have been shown in section 3.4.5.1.

TABLE 4.3.1 The 54 products used in Study I.

Name list of the 54 products					
Table Cleaner	Toilet Gel	Shampoo	Cleaner	Bowl Set	Dustpan
Shower Gel	Dental Floss	Iron	Facial Cleanser	Kettle	Candle
Condom	Deodorant	Toilet Tissue	Hair Dryer	Pan	Picnic Box
Bin	Mouthwash	Tissue	Shave Splash	Scissors	Bottle Opener
Bathroom Set	Soap Bar	Bulb	Towels	Slice Toaster	Hair Brush
Coffee Maker	Toner	Face Brush	Opener	Stew Pot	Water Maker
Facial Cream	Hand Cream	Toothpaste	Tableware	Tooth Brush	Steam Cleaner
Hand Wash Gel	Cleaning Sponge	Espresso Maker	Makeup- Remover	Chair	Mug
Washing Up Liquid	Laundry Detergent	Iron Casserole Pot	Hair Treatment	Sanitary Towel	Gift Set

4.3.2 Data collection: Online Survey and Laboratory Experiment

For the online survey, neither the settings of the displays used by the observers nor the viewing conditions can be controlled or even known. There is clearly a trade-off between colour accuracy and obtaining responses from a large number of disparate observers (typically we can carry out a highly controlled experiment in the laboratory with relatively few observers or we can carry out a large-scale experiment on the internet with many observers who may have varied backgrounds but where the degree of colorimetric and experimental control is less). However, as Moroney (2003) has noted, the advent of sRGB (and ICC colour-management workflows) has provided some degree of convergence in colour encoding and display for the Internet. Furthermore, variability in colour appearance is likely to be significantly smaller than variability in colorimetric measurements. The choice was made to accept the limitations

of colour variability in order to get responses from a diverse and large population of participants. TABLE 4.3.2 illustrates the details of research methods used for this study.

TABLE 4.3.2 The details of the Online Survey and Laboratory Experiment I used for this study.

Research activity	Research method	Data type	Data analysis method
Online Survey	Multiple Choice (6-alternative forced-choice)	Quantitative Data	Descriptive Statistic
Laboratory Experiment I	Multiple Choice of 6-alternative forced-choice + Likert Scale (5-point likert scale)	Quantitative Data	Descriptive Statistic + R-Square + Independent Chi-Square Test

4.3.2.3 Experimental structure

Two experiments (See FIGURE 4.3.2.1) were carried out (one online and one in the laboratory) to ascertain the colour that participants would prefer to buy for each product. In laboratory experiment I, participants were additionally asked to indicate, for each product, the extent to which they think colour could be related to performance or function. At the end of each experiment, participants were asked to indicate which colour (from the six coloured squares) they prefer most.

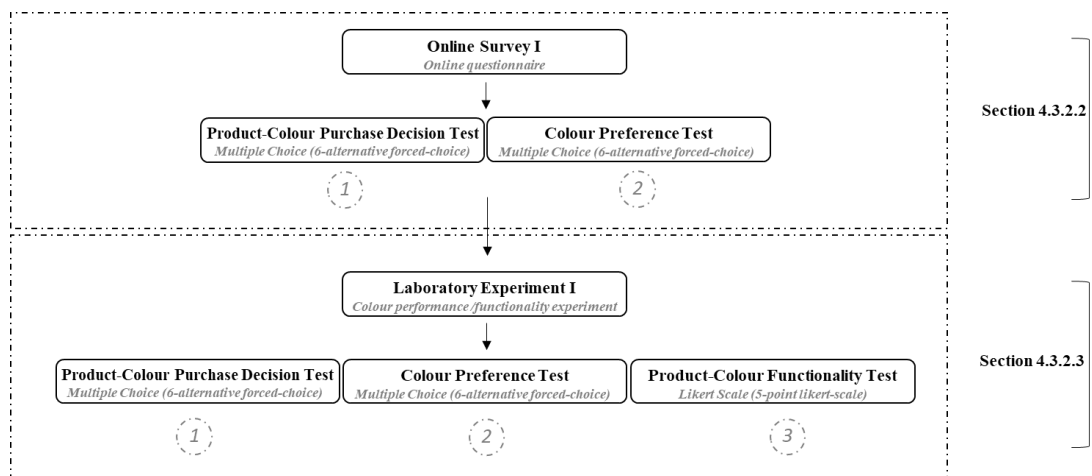


FIGURE 4.3.2.1 The experimental structure for Study I.

4.3.2.4 Online Survey I

The online survey was made and launched by using Google Form (FIGURE 4.3.2.2) and the 6-Alternative Forced-Choice research method was employed. Each participant was presented with the six coloured images for each product in turn (the order in which the products were presented varied randomly for each participant) and asked to indicate (by clicking with the mouse or tapping the screen, as appropriate) which of the coloured products they would prefer to buy. At the end of the survey, the six colour patches were displayed and participants were asked to indicate which of these was their preferred colour (note that participants were only asked once what their preferred colour was; they were asked this at the end of the activity, after choosing each product colour). The reason that observers were asked their colour preference at the end rather than at the beginning to avoid the potential for bias; for example, if colour preference was asked first, this might make the participants consider their own colour preferences when making the product-colour decisions in a way that they might not do had they not been ‘primed’ to think about colour preference. The full Online Survey is been shown in Appendix C.2.

The figure displays three sequential screenshots of the online survey interface. The first screenshot, titled 'The survey of consumers purchasing behavior of the colour tendency', contains a 'General information of participant' section with radio button options for gender (Male, Female, Other), age stage (0-20, 21-30, 31-40, 41-50, 51-60, 60-80), and nationality (Chinese, British, South Korean, Japanese, French, Australian, American, Other). The second screenshot, titled 'The survey of purchasing behavior', asks 'Which bin would you choose to buy?' and shows six 3D cylindrical bins labeled A through F in different colors. The third screenshot, titled 'Colour Preference Test', asks 'Which colour square do you prefer?' and shows six colored squares labeled A through F. At the bottom of the third screenshot, there is a progress bar indicating '100% You have it' and buttons for 'BACK' and 'NEXT'.

FIGURE 4.3.2.2 The interface of Online Survey I (consists of Product-Colour Choice Test and Colour Preference Test). The order of Product-colour Choice Test in which the products were presented randomly for each participant.

4.3.2.5 Laboratory Experiments

The online survey was followed by an almost identical experiment carried out in a laboratory (with controlled viewing conditions, lighting conditions, and display technology) with a smaller number of participants. In laboratory experiment I, a similar set of questions was asked; however, in addition, participants were asked to indicate for each product the extent to which they think colour could be related to functionality or performance. Participants did this by selecting from a 5-point likert scale (where one extreme was no relationship with functionality/performance and the other extreme was 100% relationship with functionality/performance). Subsequently, the scale values were assigned numbers (0 – 100%) and averaged to generate a mean scale value for each product that indicates the extent to which colour is perceived to be related to functionality/performance. The experimental graphical user interface was coded using MATLAB software (*FIGURE 4.3.2.3*).

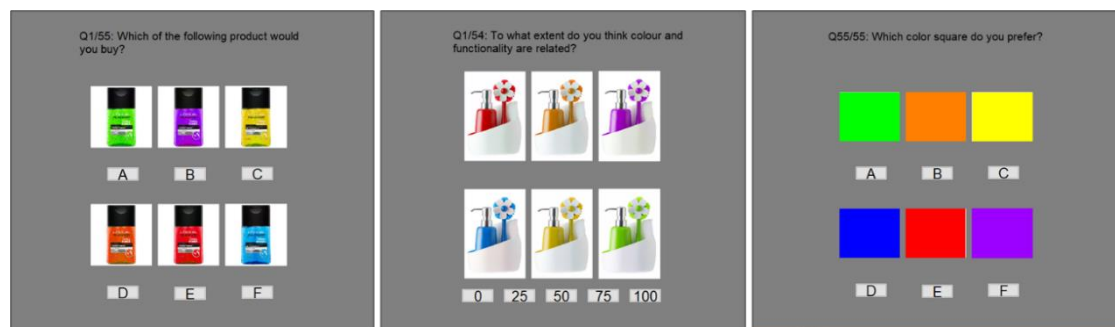


FIGURE 4.3.2.3 Graphical user interface for Laboratory Experiment I (consists of Product-Colour Purchase Decision Test, Colour Preference Test and Product-Colour Performance/Functionality Test). The order of Product-colour Choice Test and Product-Colour Performance/Functionality Test in which the products were presented randomly for each participant.

4.3.3 Participants recruitment and experiments procedure

The Online Survey I was less well-controlled than the Laboratory Experiment, due to likely variation in display technology (such as iPad, laptop, PC, smartphone etc.) and

viewing conditions (day-time or night-time). The Laboratory experiment took place in a darkened room in the Experience Design Laboratory at University of Leeds. Stimuli were displayed on an HP DreamColor LP2480zx Professional Display (24-inch Diagonal LCD Backlit Monitor, the luminance of the display white was 218 cd/m²). The size of each image was 50 × 40 mm displayed on a uniform grey background (CIE $L^* = 50$) and participants viewed the screen from about 60 cm (See FIGURE 4.3.3).

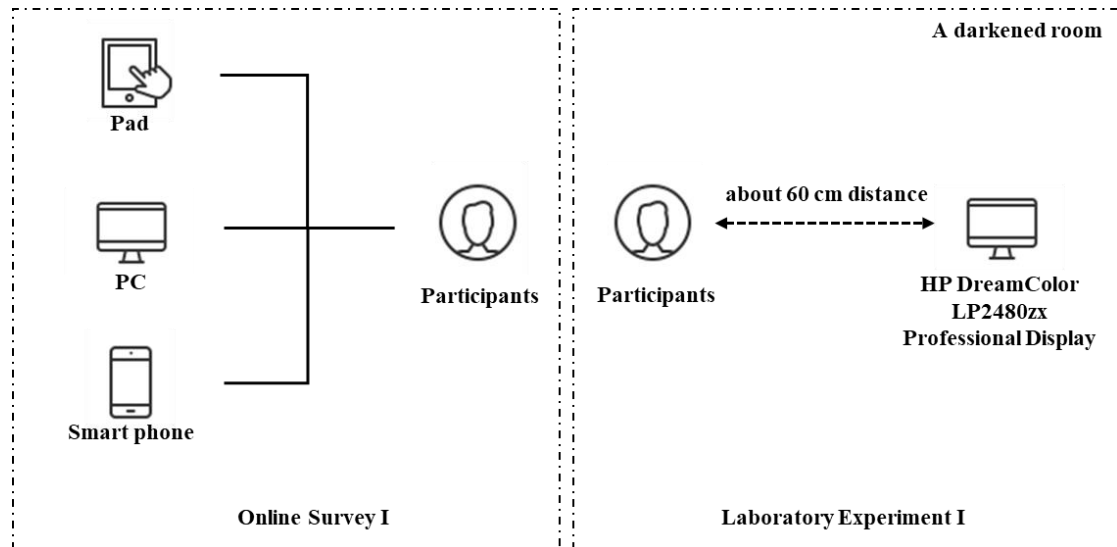


FIGURE 4.3.3 Picture of Study I experimental setting (Online Survey I and Laboratory Experiment I).

The Research Ethics Committee (Reference Number: LTDESN-045) of PVAC & Arts joint Faculty (University of Leeds) approved the experimental protocol (see Appendix B.4). The Information Consent Form and the Information Sheet Form have been shown in Appendix C.2 and Appendix C.3. In the online survey, 173 participants were recruited (62 males, 111 females; 49 UK, 73 Chinese). For Laboratory Experiment I, a total of 39 participants were recruited to take part, including 18 males and 21 females, and 14 UK and 19 Chinese (all participants of Laboratory Experiment I were students or staff at the University of Leeds).

4.3.4 Data analysis

For the data analysis, the colour that each participant selects for each product is

compared with the participant's own individual colour preference. The extent to which the chosen product colour matches the individual colour preference is calculated as a per cent figure and this will be referred to as the *colour consistency rate* (see FIGURE 4.3.4). This is done for each product; that is, the per cent of participants that indicate that they would buy that product in their favourite colour. Since there are six different colours, chance performance is about 17%. So even if there was no effect of individual colour preference on participant purchase behaviour, we would expect to find a colour consistency rate of about 17% by chance. Colour consistency rates substantially higher than 17% suggest that individual colour preferences influence participant purchase behaviour for that product (more concepts and definitions see TABLE 3.3.4, CHAPTER 3).

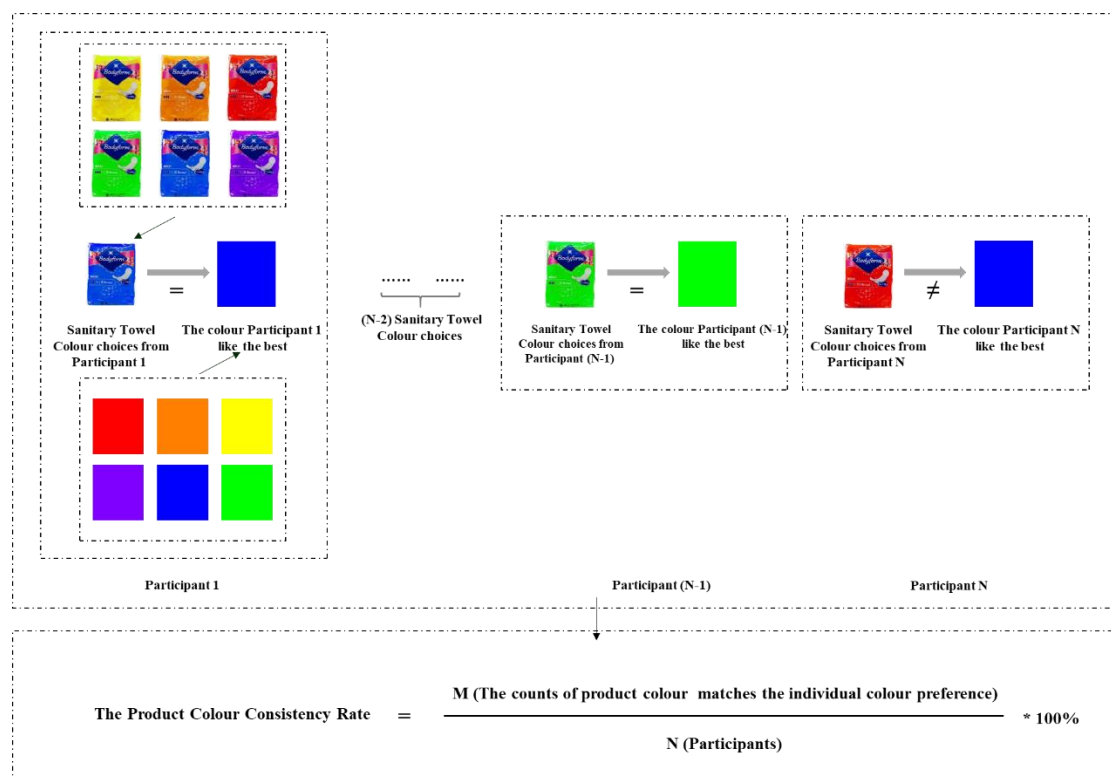


FIGURE 4.3.4 The illustration for the product colour consistency rate.

4.4 Results for Study I

Three data analysis methods were used in this study. The Chi-Squared Test for Independence will be used to test for the statistical significance ($p < 0.05$) of the effect

of experiment condition (online or in a laboratory) on colour preference data. The R-Squared Test will be employed to examine the agreement between two experiments about the colour-consistency rate and to identify the relationship between individual colour preference and primary factors. TABLE 4.4 lays out the details of data analysis methods and objectives for this study.

TABLE 4.4 Data analysis methods and objectives.

Research activities	Research methods	Data types	Data analysis	Objectives
Online Survey I (worldwide consumers)	Multiple Choice (6-Alternative Forced-Choice)	Quantitative Data	Descriptive Statistic	-To identify the universal colour preference;
				-To explore whether consumers' product colour decision is affected by colour preference;
Laboratory Experiment I	Multiple Choice (6-Alternative Forced-Choice) + Likert Scale (5-point likert scale)	Quantitative Data	Descriptive Statistic + R-Squared Test + Independent Chi-Square Test	-To investigate that is there any other factors, which influence consumers' product-colour decision (except colour preference)?
				-To examine the correlation between colour consistency rates from online survey and laboratory experiment;
				-To identify the relationship between the colour performance /functionality scores with colour consistency rate;
				-To test the agreement of the results of colour preference from an online survey and several laboratory experiments.

4.4.1 Colour preference

This section consists of individual colour preference results, product-colour purchase decision results, popular product-colour results, product-colour performance and functionality results and the connection between individual colour preference and product-colour decisions.

First, consider the data from the colour preference part of the studies which was simply about which colours people prefer in an abstract sense. For the Online Survey I, the

highest colour preference was blue (26.0%), followed by red (21.4%), orange (15.6%), yellow (12.7%), green (12.1%) and purple (12.1%). For the Laboratory Experiment I the preference scores were red (30.8%), blue (18.0%), green (15.4%), orange (12.8%), purple (12.8%) and yellow (10.3%). TABLE 4.4.1(a) shows the distribution of individual colour preferences in two experiments (including choosing frequencies and percentages).

TABLE 4.4.1(a) Distribution of individual colour preferences in two experiments.

Colour preference				
	Online Survey I		Laboratory Experiment I	
	Frequency	%	Frequency	%
Red	37	21.4	12	30.8
Orange	27	15.6	5	12.8
Yellow	22	12.7	4	10.3
Green	21	12.1	6	15.4
Blue	45	26.0	7	18.0
Purple	21	12.1	5	12.8
Total	173	100	39	100

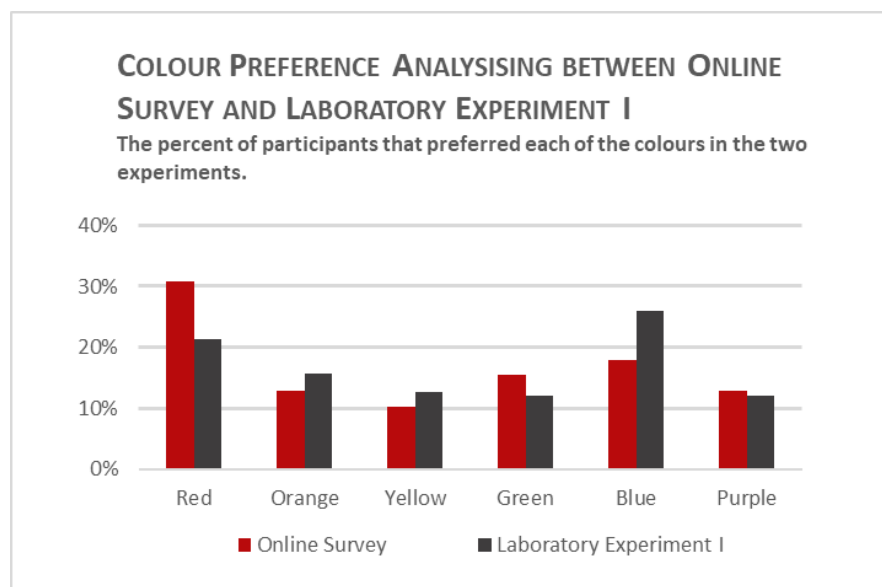


FIGURE 4.4.1 The per cent of participants that preferred each of the colours in the two experiments.

The results (FIGURE 4.4.1) are broadly consistent with those from other published

studies (e.g., Guilford and Smith, 1959; and Nemcsics and Takács, 2019) in that blue is a colour with a high preference rate and yellow is a colour with a low preference rate. There seems to be a reasonable correlation between the two experiments; however, the high preference rate for red in the laboratory experiment is a little higher than that which is typically seen. Note, however, that the sample size is smaller in the laboratory experiment ($N = 39$) than in the online experiment ($N = 173$). Note also that the results in Figure 4.4.1 are pooled over all cultures and genders for the participants.

However, a test for statistical significance was carried out using Chi-Squared (χ^2) but using the Likelihood ratio rather than the Pearson chi-squared because some counts were less than 5. Pairwise comparisons were carried out and it was found that there was no statistically significant difference ($p = 0.756 > 0.05$) between the individual colour preferences from the Online Survey I and the Laboratory Experiment I (See TABLE 4.4.1(b)).

TABLE 4.4.1(b) Statistical analysis of the online survey and Laboratory Experiment I.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.652 ^a	5	.754
Likelihood Ratio	2.633	5	.756
N of Valid Cases	212		
a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is 4.78.			

4.4.2 Product-colour purchase decision

In the online survey, the colour consistency rate (the extent to which participants select a product in their preferred colour) was greater than 17% for every product. Recall that the higher the colour consistency rate, the more participants choose products of a colour that matches their abstract colour preference. The average colour consistency rate was 34.2%. The lowest colour consistency rate was for the Washing Up Liquid (20.8%) and the highest colour consistency rate was for the Espresso Maker (48.6%). In the

laboratory experiment, the average colour consistency rate was 30.1%. The lowest colour consistency rate was for the Dental Floss (15.4%) and the highest colour consistency rate was for the Mug (51.3%). Taken together, these data suggest that individual colour preferences do affect participants' product-colour purchase decisions but that the extent of this varies between products (RQ 1).

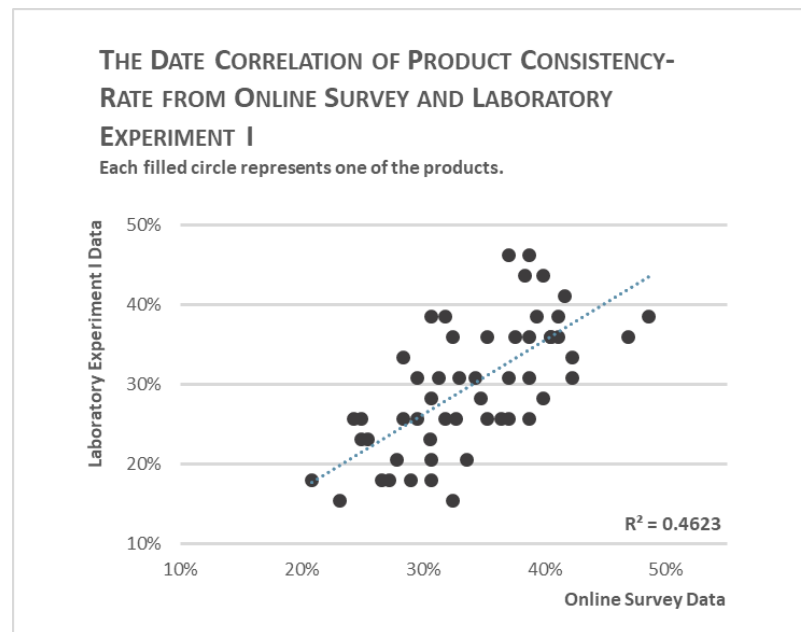


FIGURE 4.4.2 The correlation between the colour consistency rates from the two experiments with a coefficient of determination (r^2) of 0.46. Each filled circle represents one of the products.

FIGURE 4.4.2 shows the correlation between the colour consistency rates from the two experiments. The vertical and horizontal axes represent the colour consistency rate from the laboratory experiment and the online survey respectively. Each point on the graph refers to one of the 54 products and it is evident ($r^2=0.46$) that there is some agreement between the two experiments.

4.4.3 Popular product-colour

In the online experiment, some colours were very popular for certain products. If we consider products for which more than 40% of participants selected the same colour

(these can be referred to as popular product-colour) then this only happened for red and for blue colours. More than 40% of participants chose red for the Coffee Maker, Espresso Maker, Iron Casserole Pot, Pan, Slice Toaster and Stew Pot and more than 40% of participants chose blue for the Cleaner, Deodorant, Face Brush, Facial Cleanser, Makeup-Remover, Mouthwash, Shave Splash, Iron, Toilet Tissue, Tooth Brush, Towels, Toothpaste and Dental Floss (see TABLE 4.4.3). These results are consistent with the previously published results (Westland and Shin, 2015); in that earlier study blue was overwhelmingly selected by participants for the hand soap product. These data support the framework put forward in this paper (FIGURE 4.2.2).

TABLE 4.4.3 A list of products for which many participants (more than 40%) selected the same colour. Note that this only occurred for products that were red or blue.

Products	Red (%)	Orange (%)	Yellow (%)	Green (%)	Blue (%)	Purple (%)
						
Toilet Tissue					63.01	
Toothpaste					63.01	
Dental Floss					60.69	
Makeup-remover					54.34	
Mouthwash					53.18	
Shave Splash					50.34	
Cleaner					48.55	
Pan	47.40					
Slice Toaster	47.40					
Espresso Maker	46.82					
Facial Cleanser					45.66	
Deodorant					45.09	
Iron					42.77	
Iron Casserole Pot	42.77					
Coffee Maker	42.20					
Towels					41.62	
Face Brush					41.04	
Toilet Gel					40.46	
Tooth Brush					40.46	
Stew-pot	40.46					

Interestingly most of the products that were strongly preferred in a red colour are

associated with heat (colour functionality in the framework) whereas most of the products that were strongly preferred in a blue colour are associated with cleaning and/or health (this could be colour functionality or colour performance in the framework). However, a more detailed analysis of this framework follows.

4.4.4 Product-colour performance and functionality

In Laboratory Experiment I, participants were asked to rate (using a 5-point Likert scale) the extent to which colour is related to functionality or performance for each product. The responses were averaged across all observers to produce a number (between 0 and 100%) for each product (see FIGURE 4.4.4).

For some products the participants judged colour to have a strong influence on functionality or performance such as for Mouthwash (66.7%), Washing Up Liquid (57.1%) and Shower Gel (56.4%), whereas for other products participants judged colour to be a weak influence on functionality or performance such as for Scissors (13.5%), Can Opener (16.0%) and Chair (16.7%). It is clear that for products such as Mouthwash and Shower Gel the colour could indicate the efficacy, function, or smell of the product whereas for products such as scissors and the Chair colour has no relationship with these attributes. It seems therefore that the study has effectively measured the extent of colour functionality/performance.

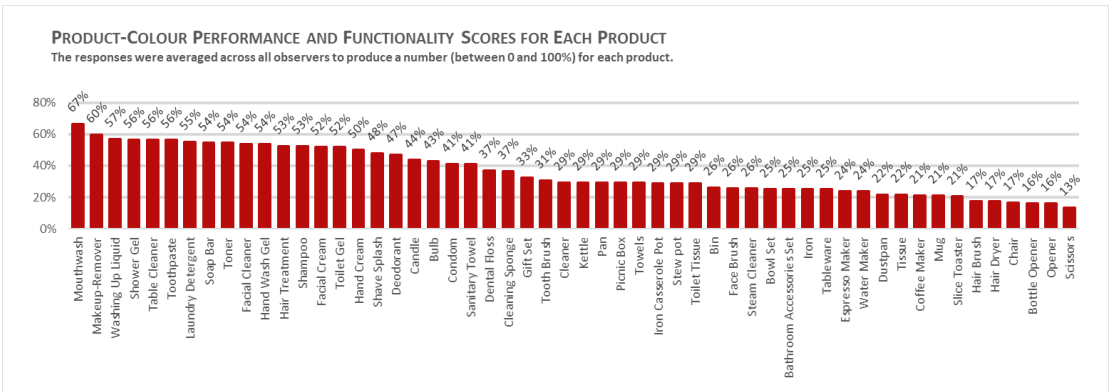


FIGURE 4.4.4 Product-colour performance and functionality scores for 54 products. The higher the scores, the greater the extent to which the participants expressed the view that colour indicated something about the functionality or performance of the product.

4.4.5 The connection between colour preference and products colour choices

The critical question, however, is whether product-colour performance and functionality scores correlate with the product colour consistency rate measured for the products in the two experiments. If our conceptual framework is supported, then we would expect high colour performance/functionality scores to be associated with low product-colour consistency rates and vice versa. FIGURE 4.4.5 shows the correlation of the colour performance/functionality scores (measured from Laboratory Experiment I) with the colour consistency rates measured from the Online Survey I (red circles) and Laboratory Experiment I (grey triangles) respectively. The coefficient of determination (r^2) between the colour performance/functionality scores and the product-colour consistency rates are 0.64 and 0.41 for the Online Survey and Laboratory Experiment I respectively.

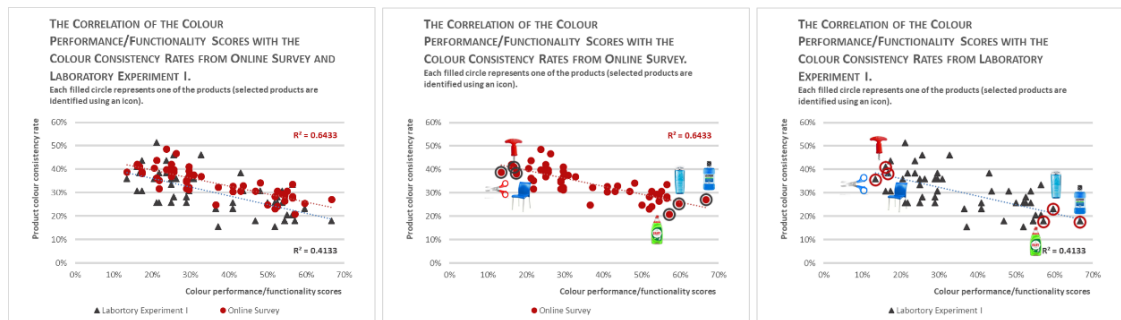


FIGURE 4.4.5 The correlation of the colour performance/functionality scores with the colour consistency rates from Online Survey I and Laboratory Experiment I. Each filled red circle or grey triangle represents one of the products (selected products are identified using an icon).

Due to the non-normal distribution of product-colour performance and functionality scores ($\text{sig.}=0.000<0.05$) and the normal distribution of the overall product colour consistency ($\text{sig.}=0.2>0.05$), the Spearman's Correlation statistical analysis has been used (TABLE 4.4.5). There is a significant correlation ($\text{sig.}=0.000<0.05$) with -0.773

correlation coefficient, note that this is a negative correlation. That may suggest even for different products, the higher product-colour performance and functionality factors influence participants product-colour choice, the lower individual colour preference influences (RQ 1.2).

TABLE 4.4.5 Spearman's Correlation statistical analysis of product-colour consistency rates and product-colour performance and functionality scores.

Spearman's Correlations				
Spearman's rho	Functionality Score	Correlation Coefficient	Functionality Score	Overall Product Colour Consistency Rates
			1	-.773**
			Sig. (2-tailed)	.000**
		N	54	54
	Overall Product Colour Consistency Rates	Correlation Coefficient	-.773**	1
			Sig. (2-tailed)	.000**
		N	54	54
	* Correlation is significant at the 0.01 level (2-tailed).			

4.5 Discussions and Conclusions for Study I

The purpose of this study is to test whether consumers' individual colour preferences (in an abstract sense rather than for a particular product) affect their intended product purchase decisions if they are given various colour choices. This work employs two experiments with visual components to investigate which colour a participant would choose if asked to select a product to purchase when there is a range of colours available. Two experiments were also designed to elicit a response about which colour each participant prefers (in an abstract sense). This section concludes the key insights and critique of research methods for this study, and also plans the next step for the research. Colour is an important marketing tool for many products. Consumers will often choose to purchase a product when it is presented with expected or preferential colours or colour schemes. Product-colour preference decisions are often associated with expected

performance, reliable function or other cultural factors depending on the type of the products. The author refers to these as primary colour factors and suggest that a consumer's individual colour preference may be important but only in the absence of these primary factors that will otherwise drive purchase behaviour. Understanding these primary factors and the situations in which they are absent could be valuable information for professionals working in product design and/or marketing. Different types of products need differently optimised strategies for product colours to stimulate purchase decisions and an appropriate colour scheme is also valuable to build a strong brand identity. One potential practical application of this work would be to use information about a consumer's individual colour preferences to make a tailored proposition; for example, to present a special offer for a toothbrush using the colour that is known to be the consumer's favourite colour with the aim that this could increase the likelihood that the consumer would make a purchase. It may be possible to obtain information about a consumer's individual colour preference by analysing their social media activity or their purchase history (potentially available through store loyalty schemes).

This study investigates whether consumers' individual colour preferences affect their purchase-decision intentions. The data from two experiments suggest that for all of the products tested participants are more likely to indicate that they would purchase a product in their favourite colour than in a random colour (RQ 1). By favourite colour, we do not mean their favourite colour for that product but rather their favourite colour in an abstract sense (individual colour preference). A conceptual framework (the full framework is presented in FIGURE 4.2.2) is presented that suggests that consumer individual colour preferences are more likely to influence consumer product purchase intentions in the absence of primary colour factors such as colour functionality and colour performance (RQ 1.1 and RQ 1.2). The data from the study are consistent with the framework and suggest a process by which it would be possible to predict in advance the products for which individual colour preferences may be important. This

framework could be used as a predictor as well, especially when looking at products with multi-colour options, such as the Apple iPod nano.

The study finds that individual colour preferences affect intended product-colour purchase decisions but that the extent of this varies from one product category to the next. Further analysis reveals that individual colour preferences are secondary to factors such as colour functionality and colour performance. This work presents new experimental data about the role of colour in product and product packaging on intended consumer purchase decisions. A conceptual framework, supported by the experimental findings, represents the relationship between individual colour preferences and product-colour choices, and more functional aspects of colour itself (such as the effect of colour on a product's performance or functionality).

Finally, it is noted that this work was concerned with that aspect of colour known as hue. However, it is acknowledged that lightness and chroma may also be important for consumer purchase decisions (Labrecque *et al*, 2013). The work in this study is also limited to household kitchen and bathroom products and it is yet to be determined whether our conceptual framework can be applied more broadly. It is clear that much more work is required in this field. TABLE 4.5 lays out the limitations for this study, the improvements and the objectives for continual studies, and the relevant chapters.

TABLE 4.5 Overview of limitations for Study I, and the improvements and the objectives for further studies, the relevant chapters are located.

Limitations	Improvements	Objectives	Chapter
- Narrow product categories (household kitchen and bathroom products only).	- To broaden the product categories (such as food, clothes etc.).	- To determine whether our conceptual framework can be applied more broadly.	5, 6
- Concerned with the aspects of colour as hue only.	- To add lightness and chroma into the colour aspects.	- To explore whether lightness and chroma may also be important for consumer purchase decisions.	8 (Further Research)
- Limited colour preference test data	- To test colour preference by using different methods	- To compare the accuracy of results between different	5, 7

collection methods (6- alternative forced- choice only);	(such as ranking, affective judgement, paired comparison etc.);	research methods;	
- Limited data collection activities (surveys only) and data type (quantitative data only).	- To use other data collection activities (interviews) and to obtain different types of data (quantitative data).	- To explore/explain why the particular regularities occur.	5

5 CHAPTER FIVE – STUDY II: THE ROLE OF COLOUR ASSOCIATION ON CONSUMERS' PURCHASEING BEHAVIOUR

‘Qualitative research should involve critical self-scrutiny by researcher, or active reflexivity. This means that the researcher should constantly take stock of their actions and their role in the research process, and subject these to the same critical scrutiny as the rest of their ‘data’. This is based on the belief that a researcher cannot be neutral, or objective, or detached, from the knowledge and evidence they are generating. Instead, they should seek to understand their role in that process. Indeed, the very act of asking oneself difficult questions in the research process is part of the activity of reflexivity.’

- Mason (2002)

5.1 Introduction

CHAPTER 4 suggests that consumer individual colour preferences are more likely to influence consumer product-colour purchase intentions in the absence of primary colour factors (*colour functionality* and *colour performance*), based on the analysis of an online survey and a laboratory experiment. The literature review from CHAPTER 2 suggested that colour association may affect the responses to individual colour preference (Palmer and Schloss, 2010); also, some researchers suggested a relationship between coloured-object association and individual colour preference (Taylor and Franklin, 2006). However, very little work has been carried out to explore whether consumers' colour associations might affect product-colour association, and how it affects consumers' product-colour decisions. Critically, Study II plan to *explore* to whether *colour association* is one of the primary factors that affects consumers' product-colour choice, and to *explore* in what extent.

Following the research design in CHAPTER 3, this work employs two research activities (an interview and a laboratory experiment) to investigate which colour a participant would choose if asked to select a product to purchase when is a range of colours available, and the reasons why they choose the colours. These two activities were also designed to elicit a response about colour preference and colour association for each participant. This work presents new experimental data about the role of colour in product and product packaging on intended consumer purchase decisions. An updated (second) conceptual framework (this framework is described in the next section) captures the relationship between individual colour associations and consumers' product-colour purchase decision reasons, and explores the relationship between *colour association factor* and colour preference factor when consumers make product-colour decisions. This framework will be used to further explain and understand why (or to what extent) individual colour preference seems to matter.

This chapter consists of five sections. Section 5.1 summarises the achievement of this chapter. Section 5.2 presents the research questions, objectives and an updated framework. Section 5.3 outlines the experimental configuration for this study. Section 5.4 displays the key findings according to the research questions. Section 5.5 reflects upon the results and the critically evaluates the research methods, before outlining further directions for the research.

5.1 Introduction					
5.2 Research Design for Study II	5.2.1 Research questions, purposes and strategy for Study II	5.2.2 Research hypotheses and framework for Study I			
5.3 Experimental Configuration	5.3.1 Preparation of experimental samples	5.3.2 Data collection methods: Interview and Laboratory experiment II	5.3.3 Participants recruitment and experimental procedure	5.3.4 Data analysis	
5.4 Results	5.4.1 Colour preference	5.4.2 Product-colour purchase decision	5.4.3 Colour square associations	5.4.4 Product-colour decision reasons	5.4.5 Correlation between colour associations and product-colour decision
5.5 Discussions and Conclusions	5.5.1 Key insights	5.5.2 Critique of the research methods and next step			

FIGURE 5.1 Structure for CHAPTER 7.

5.2 Research Design for Study II

The research design for Study II consists of research questions, research purposes, research strategy, research activities, and updated research hypotheses with an updated framework.

5.2.1 Research questions, purposes and strategy for Study II

In Study II, one main research question (RQ 2) and three sub-research questions (RQ 2.1, RQ 2.2 and RQ 2.3) were translated into the purposes for this chapter: 1) to *explore* whether colour association influence consumers' product-colour choice in all product categories, and explore in what extent; 2) to *understand* the consumers' colour associations when they see the colours; 3) to *understand/explain* the reasons that consumers purchase a colour of a product; 4) to *explore/explain* the relationships between colour association factor and individual colour preference factor when consumers purchase a product of a particular colour. For dealing with the *explore / understand / explain* nature of the research purposes, the Deductive Strategy and Abductive Strategy have been used to collect *qualitative* and *quantitative* types of data. An interview (*Interview*) and a laboratory experiment (*Laboratory Experiment II*) has been employed (details see TABLE 5.2.1).

TABLE 5.2.1 Research questions, strategies and activities for Study II.

Research Question	Purpose	Research Strategy	Research Activity
RQ 2: Whether colour association influence consumers' product-colour decision?	-To <i>explore</i> whether colour association influence consumers' product-colour choice in all product categories, and <i>explore</i> in what extent;	Deductive Strategy (Qualitative Data Type)	An Interview (Interviews) + A Laboratory Experiment
RQ 2.1: How many classifications of colour association consumers will provide when they see the colour squares?	-To <i>understand</i> the consumers' colour associations when they see the colours;	+ Abductive Strategy (Quantitative Data Type)	(Laboratory Experiment II)

RQ 2.2: What are the reasons that consumers will provide when consumers purchase a colour of a product?	-To <i>understand/explain</i> the reasons that consumers purchase a colour of a product;
RQ 2.3: What is the relationship between individual colour preference and colour association when consumers purchase a colour of a product?	-To <i>explore/explain</i> the relationships between colour association factor and individual colour preference when consumers purchase a product of a particular colour.

5.2.2 Research hypotheses and framework for Study I

The earlier conceptual framework (FIGURE 4.2.2) from Study I was presented to show the effect of *colour functionality* and *colour preference* on consumers' product-colour preferences even though they have strong personal preferences for other colours in an abstract sense. Study I found that personal colour preference affects intended product-colour purchase decisions but that the extent varies between product categories and that personal colour preferences are more likely to influence consumer product-purchase intentions in the absence of these primary colour factors (*colour functionality* and *colour preference*). However, some products are not particularly related to any of these existing factors and therefore a new primary factor, the *colour association factor*, has been introduced in an updated conceptual framework.

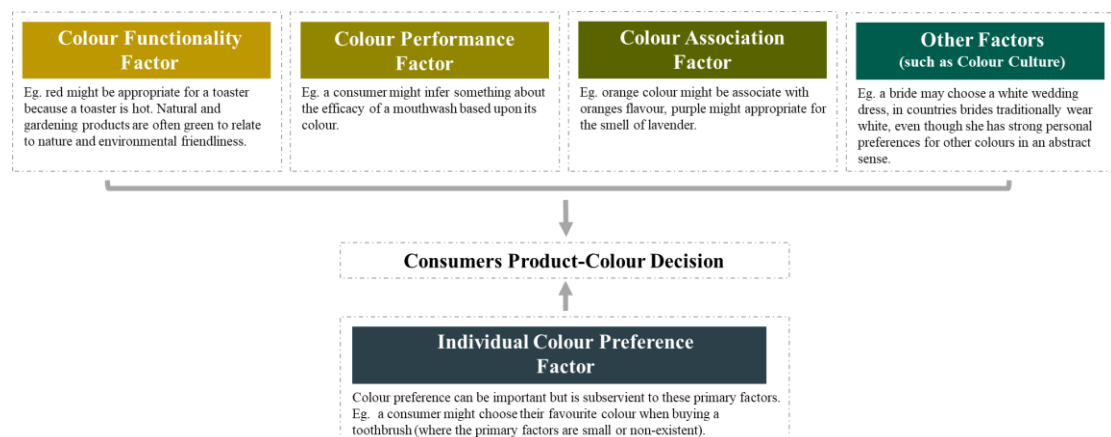


FIGURE 5.2.2 Framework for Study I.

The updated hypothesis is that a *colour association factor* is one of the primary factors that could drive consumer purchase decisions in some circumstances (details see FIGURE 5.2.2). The *colour association factor* relates to whether a colour is appropriate (in terms of association/information/meaning) for a product. The difference between the colour association factor and the previous factors (*colour functionality* and *colour performance*) is that in this case, it is about the associations that the colours have; whereas the colour functionality factor is about the function of the object or product. In some cases, such consumer inference may not be correct but nevertheless, such colour associations may drive consumer purchases. For example, a red colour might be associated with strawberry flavour, purple might be appropriate for the smell of lavender. Or a consumer might infer that gardening products are often green; the colour gold is related to goods of high quality and price (Pancer *et al.*, 2017). This study captures both qualitative and quantitative data for 51 products and explicitly tests the hypothesis that colour association might be an important primary factor.

5.3 Experimental Configuration

The experimental configuration consists of samples preparation, data collection method, participant recruitment and experimental procedure, and data analysis.

5.3.1 Experimental sample preparation

In this study, 51 products were selected (see TABLE 4.3.1). The product categories were expanded from Study I including household kitchen/bathroom products, clothes and food products. Six colour squares were continually used to determine participant individual colour preferences (see Section 3.4.1.1). Each of the products was digitally manipulated in Adobe Photoshop to create images in each of the six colours. Appendix D.1 shows the coloured images for all 51 products. The CIELAB colour coordinates

and the colour variability images for Study II have been shown in Appendix D.1. Furthermore, variability in colour appearance is likely to be significantly smaller than variability in colorimetric measurements.

TABLE 5.3.1 The 54 products used in Study II.

Name list of the 51 products					
Alarm Clock	Cream	Hand Wash	Milk	Shoe	Tie
Back Cushion	Dental Floss	Hat	Mouse	Shower Gel	Toner
Bag	Deodorant	Headphone	Notebook	Smart Phone	Tool Kit
Bike	Condoms	Ice Cream	Pan	Soap Bar	Toothpaste
Calculator	Makeup-Remover	Laptop	Pant	Sock	Trousers
Candy	Washing Up Liquid	Laundry Detergent	Pen	Sofa	T-Shirt
Cheese	Floor Lamp	Lighter	Photo frame	Suitcase	USB
Chocolate	Gloves	Shave Splash	PlayStation	Table Cleaner	Vase
Coffee maker	Hand Cream	Yogurt			

5.3.2 Data collection: Interview and Laboratory Experiment II

Two research activities (an interview and a laboratory experiment) and three research methods (semi-structured interview, multiple choice for 6-alternative-forced-choice and multiple choice for rank-order) were employed for Study II. The purpose of employing two data collection activities was to obtain complementarity to elaborate more fully on the results gathered from one activity with those from another. (Greene *et al.*, 1989). The laboratory experiment, on the other hand, was to support testing the hypotheses (see FIGURE 5.2.2) by matching them with data.

5.3.2.1 Experimental structure

Two research activities (see FIGURE 5.3.2.1) were carried out in a laboratory (with controlled viewing conditions, lighting conditions and display technology) to ascertain the colour that participants would prefer to buy for each product (similar with an online survey, Study I). In the interviews, participants were additionally asked to indicate, for each product, why they choose this colour. On the other hand, the interviews aimed to collect in-depth data on characteristic or to produce a description and also to explain

further observations. At the end of Study II, participants were asked to give an order for their colour preference for six colours (Laboratory Experiment II), also to provide the colour associations for each colour squares (Interview).

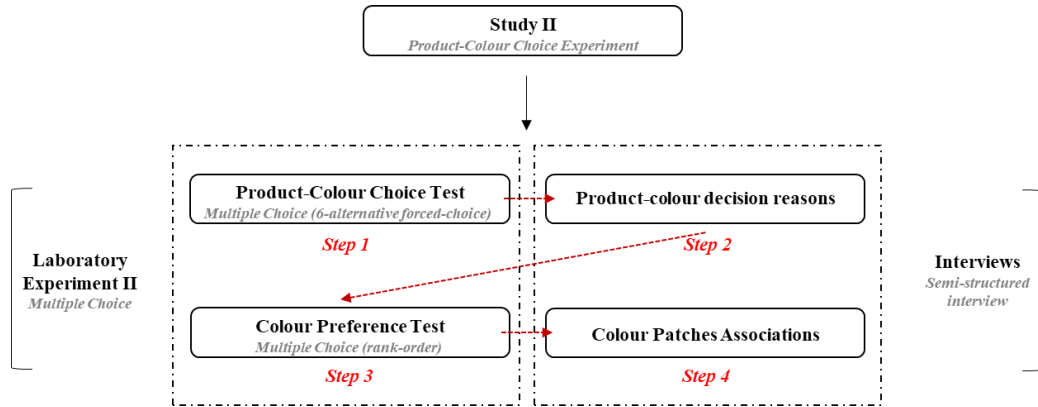


FIGURE 5.3.2.1 The experimental structure for Study II.

5.3.2.2 Survey and Interview

The survey was made and coded using MATLAB (see FIGURE 5.3.2.2), and the multiple choice for 6-alternative-forced-choice (6-AFC) and the multiple choice for rank-order (for colour preference part) research methods were employed. Each participant was presented with the six coloured images for each product in turn (the order in which the products were presented varied randomly for each participant) and asked to indicate (by clicking with the mouse) which of the coloured products they would like to buy (Step 1). At the end of the experiment (after which all 51 products had been evaluated), the six coloured squares were displayed, and the participants were asked to indicate a colour preference order for these six colours (Step 3, see FIGURE 5.3.2.2). In addition, each survey was combined with an interview (one-to-one and face-to-face method). Participants were additionally asked to indicate, for each product, why they choose this colour (Step 2); and also, to provide for each colour square, what do they associate (Step 4). The qualitative data from the interviews were recorded using a voice recorder.

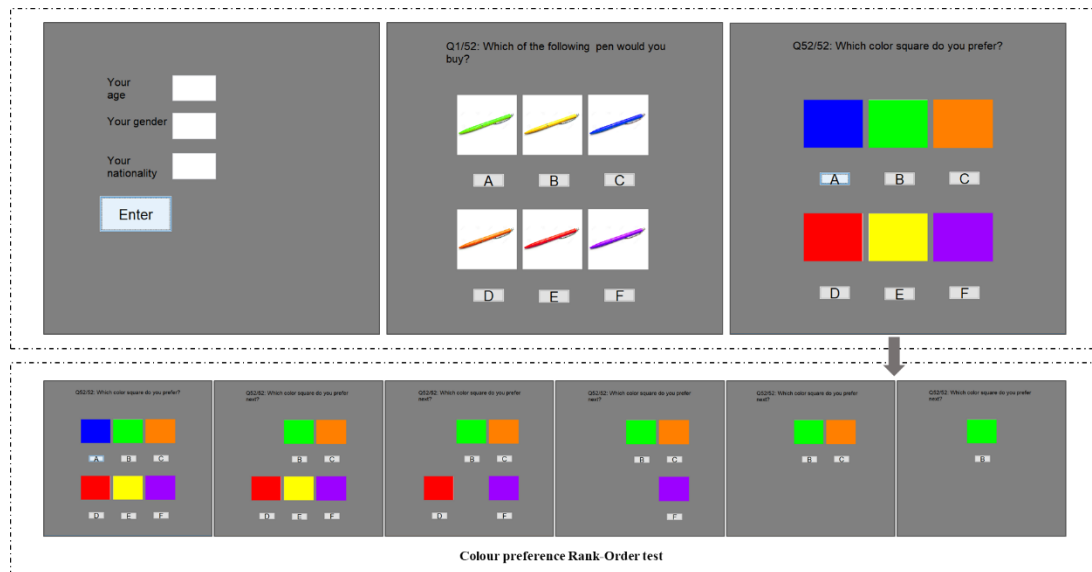


FIGURE 5.3.2.2 Graphical user interface for Laboratory Experiment II. The order of Product-colour Choice Test in which the products were presented randomly for each participant.

5.3.3 Participants recruitment and experiments procedure

The laboratory experiment took place in a dark room in the Experience Design Laboratory at University of Leeds. Stimuli were displayed on an HP DreamColor LP2480zx Professional Display (24-inch Diagonal LCD Backlit Monitor, the luminance of the display white was 218 cd/m²).

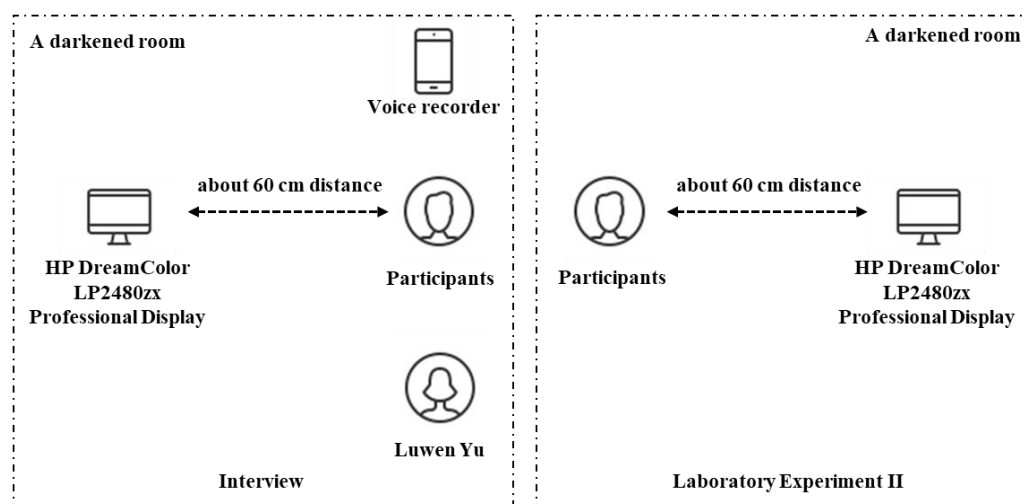


FIGURE 5.3.3 Picture of Study II experimental setting (Interview and Laboratory Experiment II).

The size of each image was 50×40 mm displayed on a uniform grey background (CIE $L^* = 50$) and participants viewed the screen from about 60 cm. A total of 37 participants (18 males and 19 females) were recruited to take part in the Interview and Laboratory Experiment II (see FIGURE 5.3.3).

5.3.4 Data analysis

For Interview data analysis, a template analysis method was investigated using keyword frequency counting to analyse the classifications of colour associations that consumers provided when they see the colour squares, and also to lay out the reasons for why consumers purchase a product of a particular colour. For Laboratory Experiment II data, Descriptive Statistic and R-Square Test were employed to test whether colour association influence consumers' product-colour purchase decisions and to identify the relationship between colour preference factor and colour association factor when consumers purchase a product of a particular colour.

TABLE 5.3.4 The experimental details and data analysis methods for Interview and Laboratory Experiment II used for this study.

Research activity	Research method	Data type	Data analysis method
Interview	Semi-structured interviews	Qualitative Data	Template Analysis
Laboratory Experiment II	Multiple Choice of 6-alternative forced-choice + Multiple Choice of rank-order	Quantitative Data	Descriptive Statistic + R-Square Test

5.4 Results for Study II

This section consists of individual colour preference results, product-colour purchase decision results, colour square association results, product-colour decision reason results, the connection between colour associations and product-colour purchase

decision reason, and correlation between product-colour association and product-colour consistency.

5.4.1 Colour preference

In this study, two research methods (two statistical methods) were used to analyse the colour preference results: Multiple Choice for N-Alternate Forced-Choice (in this case, 6-AFC) and Multiple Choice for Rank-Order (Rank-Order). The use of the Multiple Choice for N-Alternate Forced-Choice method could also be criticised if, as is usually the case, N is very small since in theory a small change in one of the colours (for example, a neutral red to a slightly warmer red) may affect which colour is selected in the forced-choice method. It may be that other experimental paradigms (such as rank-order) may be more robust.

For the Laboratory Experiment II the participants placed the six colours in rank order. A preference score for each colour S_i ($i = 1$ to 6) was obtained according to Eqn 1,

$$S_i = \sum_{j=1:M} V_j \quad (\text{Eqn 1})$$

where V_j for observer j is taken from the set [1, 0.8, 0.6, 0.4, 0.2, 0] according to the rank order (the first ranked colour is given $V_j = 1$, the second ranked colour is given $V_j = 0.8$, etc.) for the observer and j is 1 to M (where M is the number of observers). Once the preference scores S_i were obtained for each colour they were normalised (to sum to unity) and expressed as a per cent value P_i as shown in Eqn 2,

$$P_i = 100 * S_i / (\sum_{i=1:6} S_i) \quad (\text{Eqn 2})$$

The P_i values are listed in Table 5.8 for rank-order (to allow easy comparison with the 6-AFC method) but there are no associated frequency scores.

The preference scores for the Laboratory Experiment II when it is treated as a 6-AFC were blue (32.4%), followed by red (21.6%), purple (21.6%), orange (18.9%), green (2.7%) and purple (2.7%); the Rank-Order data the preference scores were blue (21.8%), followed by red (21.4%), orange (18.2%), purple (15.3%) yellow (12.8%) and green (10.5%) (see TABLE 5.4.1).

TABLE 5.4.1 The counts and percentages for the Laboratory Experiments II by using Multiple Choice for 6-Alternate Forced-Choice and Multiple Choice for Rank-Order statistical methods.

Colour preference in Study II				
	Multiple Choice for 6-Alternate Forced-Choice		Multiple Choice for Rank-Order	
	Frequency	%	Frequency	%
Red	8	21.6	*	24.1
Orange	7	18.9	*	17.8
Yellow	1	2.7	*	13.0
Green	1	2.7	*	10.6
Blue	13	35.1	*	22.0
Purple	7	18.9	*	15.1
Total	37	100	*	100

FIGURE 5.4.1 shows the data from two statistical methods in graphical form (converted to per cent figures to allow ease of comparison between experiments that include different numbers of participants) and it is evident that there is a similarity between the two statistical methods. Red and blue are strongly preferred colours in both the two statistical methods and yellow and green are weakly preferred.

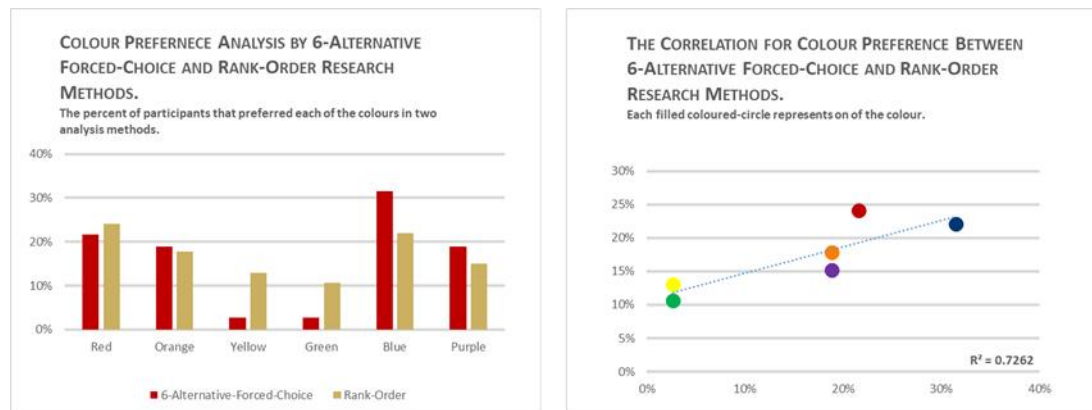


FIGURE 5.4.1 Distribution of individual colour preferences in two statistic methods (the per cent of participants that preferred each of the colours in the two analysis methods).

FIGURE 5.4.1 also shows the correlation between the results for individual colour preferences from two research/ statistical methods. The vertical and horizontal axes

represent the individual colour preference percentages from rank- order research method and 6-AFC method respectively. Each coloured circle on the graph refers to a colour and it is evident ($r^2=0.80$) that there is still an agreement between the two methods (more details will discuss in CHAPTER 7).

5.4.2 Product-colour purchase decision

For the data analysis, the product-colour that each participant selects for each product is compared with the participant's own individual colour preference rank-order result (for each colour-patch). This is done for each product (also for each colour-patch); that is, the per cent of participants that indicate they would buy that product in their individual colour preference (consider with their colour preference order). FIGURE 5.4.2 (a) shows the distribution of the colour consistency rate for the laboratory experiment when it threatened as rank-order method were 33.7% for first preferred-colour, 22.6% for second preferred-colour, 15.4% for third preferred-colour, 9.4% for fourth preferred-colour, 12.7% for fifth preferred-colour and 6.4% for sixth preferred-colour. This suggests that consumers are more likely to prefer a product a particular colour, the more they like that colour. In other words, individual colour preferences do affect participants' purchase decisions further (Jiang *et al.*, 2020).

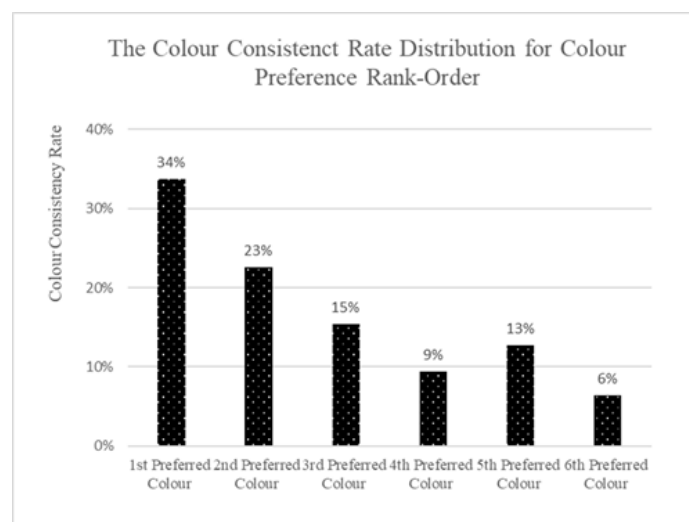


FIGURE 5.4.2 (a) The distribution of the product-colour consistency rates for the Laboratory Experiment II threatened as Rank-Order method. The 1st preferred colour,

2nd preferred colour and 3rd preferred colour etc. are referred to as the first/second/third etc. colours participant chose when they did the individual colour preference rank-order test.

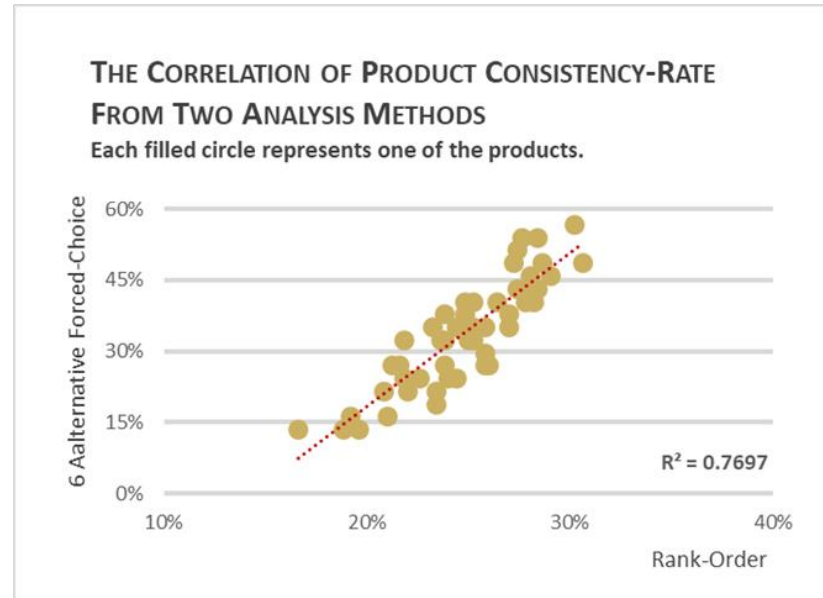


FIGURE 5.4.2 (b) The correlation between the colour consistency rates from the two research/ statistical methods and it can be seen that the coefficient of determination (r^2) is 0.77. Each filled circle represents one of the products.

5.4.3 Colour square associations

To explore the connection between colour-association and product-colour-association, the ‘template approach’ analysis method (King, 2012) has been recruited to code and organise qualitative data from interviews. NVivo, which offers quick and easy access to code materials, was used. Three sequential steps for template approach as follows: 1) creating a coding scheme for each colour name; 2) coding the data to each colour; 3) gathering similar data in one place. The transcribed data from each interview was first coded based on the words/phrases related to colour patches. The descriptive themes that are close to the data were narrowed to the interpretive theme. Finally, the data clustered in one place. FIGURE 5.4.3 demonstrates a passage from a transcription (blue colour square associations).

Cases				
Name	Files	References		Modified By
Colour Meanings		0	0	LUWEN YU
Blue		0	0	LUWEN YU
Female		0	0	LUWEN YU
broad-minded		1	1	LUWEN YU
calm		6	6	LUWEN YU
cleanness		3	3	LUWEN YU
expensive		1	1	LUWEN YU
fashion		1	1	LUWEN YU
fresh		4	4	LUWEN YU
jeans		1	1	LUWEN YU
lofty		1	1	LUWEN YU
melancholy		1	1	LUWEN YU
men		1	2	LUWEN YU
nature		1	1	LUWEN YU
original		1	1	LUWEN YU
quiet		1	1	LUWEN YU
rational		2	2	LUWEN YU
sea		6	6	LUWEN YU
sky		4	4	LUWEN YU
smart		1	1	LUWEN YU
space		1	1	LUWEN YU
sportswear		1	1	LUWEN YU
steady		1	1	LUWEN YU
water		2	2	LUWEN YU
Male		0	0	LUWEN YU
Green		0	0	LUWEN YU
Orange		0	0	LUWEN YU
Purple		0	0	LUWEN YU
Red		0	0	LUWEN YU
Yellow		0	0	LUWEN YU

FIGURE 5.4.3 (a) An example of themes in a hierarchical coding scheme (capture on NVivo).

Code	File	File Folder	File Size	Kappa	Agreement	A and B (%)	Not A and No	Disagreeme	A and Not B	B and Not
Colour Associations\Blue\Female	F-C-1	Files\Word\Femal	2445 chars	1	100	0	100	0	0	0
Colour Associations\Blue\Female	F-C-10	Files\Word\Femal	2379 chars	1	100	0.13	99.87	0	0	0
Colour Associations\Blue\Female	F-C-11	Files\Word\Femal	2368 chars	1	100	0.42	99.58	0	0	0
Colour Associations\Blue\Female	F-C-12	Files\Word\Femal	2457 chars	0.725	99.51	0.65	98.86	0.49	0	0.49
Colour Associations\Blue\Female	F-C-13	Files\Word\Femal	2516 chars	0.5785	99.48	0.36	99.13	0.52	0	0.52
Colour Associations\Blue\Female	F-C-14	Files\Word\Femal	2305 chars	0.7055	99.39	0.74	98.66	0.61	0	0.61
Colour Associations\Blue\Female	F-C-15	Files\Word\Femal	2343 chars	0.3979	99.36	0.21	99.15	0.64	0	0.64
Colour Associations\Blue\Female	F-C-2	Files\Word\Femal	2413 chars	1	100	0.17	99.83	0	0	0
Colour Associations\Blue\Female	F-C-3	Files\Word\Femal	2490 chars	0.4217	99.24	0.28	98.96	0.76	0	0.76
Colour Associations\Blue\Female	F-C-4	Files\Word\Femal	2203 chars	1	100	0.14	99.86	0	0	0
Colour Associations\Blue\Female	F-C-5	Files\Word\Femal	2474 chars	0	99.56	0	99.56	0.44	0	0.44
Colour Associations\Blue\Female	F-C-6	Files\Word\Femal	2363 chars	1	100	0.13	99.87	0	0	0
Colour Associations\Blue\Female	F-C-7	Files\Word\Femal	2630 chars	0.8742	99.85	0.53	99.32	0.15	0	0.15
Colour Associations\Blue\Female	F-C-8	Files\Word\Femal	3101 chars	0.5482	98.9	0.68	98.23	1.1	0	1.1
Colour Associations\Blue\Female	F-C-9	Files\Word\Femal	2357 chars	1	100	0	100	0	0	0
Colour Associations\Blue\Female	F-I-1	Files\Word\Femal	2411 chars	0.8738	99.75	0.87	98.88	0.25	0	0.25
Colour Associations\Blue\Female	F-K-1	Files\Word\Femal	2277 chars	1	100	0	100	0	0	0
Colour Associations\Blue\Female	F-M-1	Files\Word\Femal	2416 chars	0.8881	99.83	0.66	99.17	0.17	0	0.17
Colour Associations\Blue\Female	F-M-2	Files\Word\Femal	2421 chars	0.8415	99.88	0.33	99.55	0.12	0	0.12

FIGURE 5.4.3 (b) An example of Kappa Coefficient dyadic comparison between LUWEN YU and her colleague ZHENGHONG LI in Female's colour blue association (capture on NVivo).

Before the template analysis, the dyadic comparison, Kappa Coefficient, was used to compare the similarities and differences between how individuals code in this study. Zhenhong Li, one of my colleagues has been invited to code part of this work. The average of Kappa Coefficient is 0.782 for Female's colour blue association. That suggests the author have addressed the possibility that the coding might be subjective (example is shown in FIGURE 5.3.4 (b)).

For colour-patch-association, there were 48 associations for the red-colour, the highest colour association for red was Culture that the weighted percentage was 17.12%, followed by Passion (9.01%) etc.; 27 from orange-colour, the highest association for orange was Oranges (30.51%), followed by Warm (13.56%) etc.; 35 associations from yellow, the highest was Lemon (15.71%), followed by Bright (10.00%) etc.; 36 associations from green, the highest was Fresh (12.90%), followed by Grass (12.90%) etc.; 28 associations from blue, the highest was Calm (13.92%), followed by Fresh (13.92%) etc.; and 30 associations from purple, the highest was Lavender (16.33%), followed by Luxury (8.16%) etc.

The responses were generally identified into five following groups: 1) Character (such as brave); 2) Objective (such as oranges and lemons); 3) Emotional Associations (such as passion and calm); 4) Psychological (such as happy and warm) and 5) Sensational associative (such as hot and cool) (RQ 2.1). Appendix D.3 provides the rank-ordered listing of keywords which participants provided for the colours (red, orange, yellow, green, blue and purple).

5.4.4 Product-colour decision reasons

For analysing product-colour-association, three sequential steps for coding as following: 1) creating a master node named by products' name and producing six sub-schemes under product' name by colour-name; 2) coding words/phrase related to each product-colour; 3) gathering similar data in each colour. The list of choosing reason keyword, including counts and weighted percentages for each reason, were generated for each

product. FIGURE 5.4.4 demonstrates an example (Coffee Maker) in a hierarchical coding scheme, shows the rank-ordered listing of keywords which participants provided for choosing a coffee maker.

Name	Files	References	Created On	Created By
Coffee Maker		0	0 12/04/2018 17:32	LUWEN YU
Red		0	0 16/04/2018 14:38	LUWEN YU
kitchen		1	1 16/04/2018 14:38	LUWEN YU
decoration		1	1 16/04/2018 14:47	LUWEN YU
professional		1	1 16/04/2018 14:59	LUWEN YU
hot-drink		1	1 16/04/2018 15:02	LUWEN YU
bright		1	1 16/04/2018 15:49	LUWEN YU
refresh		1	1 16/04/2018 15:50	LUWEN YU
stimulate		1	1 16/04/2018 16:13	LUWEN YU
warm		2	2 16/04/2018 16:03	LUWEN YU
coffee-bean		7	7 16/04/2018 14:59	LUWEN YU
Purple		0	0 16/04/2018 14:40	LUWEN YU
decoration		1	1 16/04/2018 14:40	LUWEN YU
Orange		0	0 16/04/2018 14:56	LUWEN YU
warm		2	2 16/04/2018 15:11	LUWEN YU
coffee-bean		5	5 16/04/2018 14:56	LUWEN YU
Blue		0	0 16/04/2018 15:04	LUWEN YU
cool-down		1	1 16/04/2018 15:04	LUWEN YU
Colour Preference		13	13 12/04/2018 17:33	LUWEN YU

FIGURE 5.4.4 An example (Coffee Maker) of themes in a hierarchical coding scheme (capture on NVivo).

Participants provided nine reasons to Coffee Maker for choosing red-colour, two reasons for orange-colour, one for blue-colour, one for purple-colour and 13 for individual colour preference. Interestingly some of the product-colour decision reasons are connected with colour-square associations (for example, for Coffee Maker, the reasons of bright and warm from red-colour and orange-colour are found from red-colour and orange-colour associations). This suggests colour association may influence participant purchase behaviour of that product to support the updated framework (RQ 2.2). Appendix D.5 provide the rank-ordered listing of keywords (including counts number and weighted percentages) which participants provided for the product-colour decision reasons (51 products).

5.4.5 Correlation between colour associations and product-colour decision

The qualitative result from product-colour decision reasons for each product is

compared with the colour patch association result to explore the relationship between them. In this study, totally, 1922 product-colour decision reasons were received from 51 products (including colour preference reasons), more than one third of them (667 reasons, 35.22%) could be found from colour-patch associations (the connected reasons were noted in Appendix D.4 with bold and underline).

5.4.5.1 Product-colour association score

For data analysis, *the product-colour association score* has been introduced (the extent to which the product-colour decision reason matches the colour squares associations is calculate as a weight percentage figure). FIGURE 5.4.5 (a) shows a *product-colour association score* example for Alarm Clock. Figure lists all of the reasons for which participants say they chose a particular product colour (in this case, Alarm Clock). Those reasons that are underlined are those for which there is a colour-association connection. The product-colour association score is the sum of percentages of each of the underlined reasons.

Product Name	Colour Name	Word (Association)	Count	Weighted (%)	Word (Association)	Count	Weighted (%)
Alarm Colck	Colour Preference		11	23.91			
	Red	<u>Alarm</u>	<u>3</u>	<u>6.52</u>	<u>Cheerful</u>	<u>1</u>	<u>2.17</u>
		Refresh	3	6.52	Colour Combination	1	2.17
		Tense	3	6.52	Decoration	1	2.17
		Noticeable	2	4.35	Morning	1	2.17
		<u>Bright</u>	<u>1</u>	<u>2.17</u>	<u>Passion</u>	<u>1</u>	<u>2.17</u>
	Orange	Active	1	2.17	<u>Warm</u>	<u>1</u>	<u>2.17</u>
		Cute	1	2.17			
	Yellow	<u>Bright</u>	<u>1</u>	<u>2.17</u>	<u>Refresh</u>	<u>1</u>	<u>2.17</u>
		<u>Morning</u>	<u>1</u>	<u>2.17</u>	<u>Sun</u>	<u>1</u>	<u>2.17</u>
	Green	<u>Fresh</u>	<u>1</u>	<u>2.17</u>			
	Blue	<u>Calm</u>	<u>2</u>	<u>4.35</u>	Cool-Down	2	4.35
	Purple	Colour Combination	2	4.35	Clam	1	2.17
		Decoration	2	4.35	<u>Cool-Down</u>	<u>1</u>	<u>2.17</u>



$$\begin{aligned}
 \text{The Product-Colour Association Score} = & 6.52\% (\text{Alarm}) + 2.17\% (\text{Bright}) + 2.17\% (\text{Cheerful}) + 2.17\% (\text{Passion}) \\
 & + 2.17\% (\text{Warm}) \\
 & + 2.17\% (\text{Bright}) + 2.17\% (\text{Refresh}) + 2.17\% (\text{Morning}) + 2.17\% (\text{Sun}) \\
 & + 2.17\% (\text{Fresh}) \\
 & + 4.35\% (\text{Calm}) \\
 & + 2.17\% (\text{Cool-down}) = 37\%
 \end{aligned}$$

FIGURE 5.4.5 (a) The illustration for the product-colour association score (example for Alarm Clock). The connected reasons with colour square associations were noted with bold and underline (coloured only in this illustration).

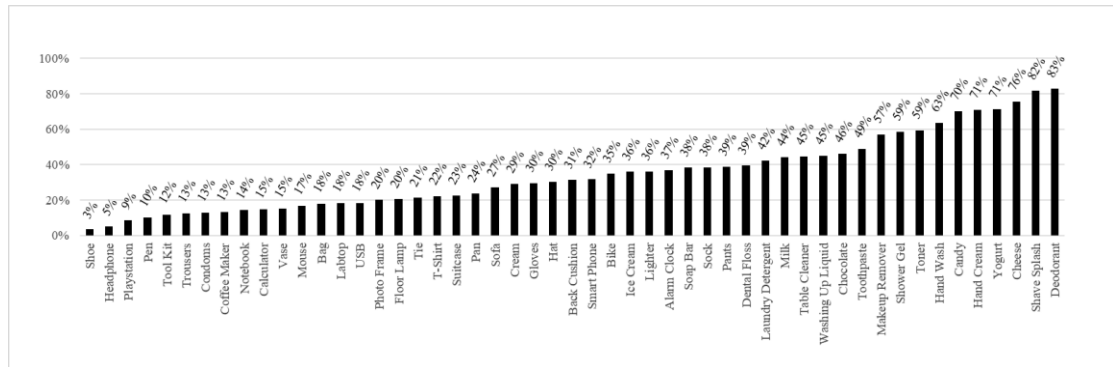


FIGURE 5.4.5 (b) Product-colour association scores for 51 products.

The responses for product-colour association score were averaged across all participants to produce a number (between 0 and 100%) for each product. The average score was 34.56%. For some products, participants judged colour to be a strong influence on colour-patch association such as Deodorant (83%), Shave Splash (82%) and Cheese (76%); however, for other products, colour only weakly influenced colour-patch association such as Shoe (3%), Headphone (5%) and PlayStation (9%) (see FIGURE 5.4.5 (b)). It is clear that, for a product such as Shave Splash and Deodorant, participants indicated that the product colours associate with colour association; products such as Shoe and Trousers have no connection with these attributes.

5.4.5.2 Correlation between colour association scores and product-colour consistency rate

The critical question, however, is whether that product-colour association scores correlate with the product colour consistency rate for the product. If the conceptual framework is supported, the expectation that high product-colour association scores to be an association with low product colour consistency rate and vice versa. FIGURE 5.4.6 shows the correlation of product-colour association scores with product colour consistency rate, (each filled diamond symbol represents one product). The coefficient of deamination (r^2) between product-colour association scores and product-colour

consistency rate is 0.32 (RQ 2.3).

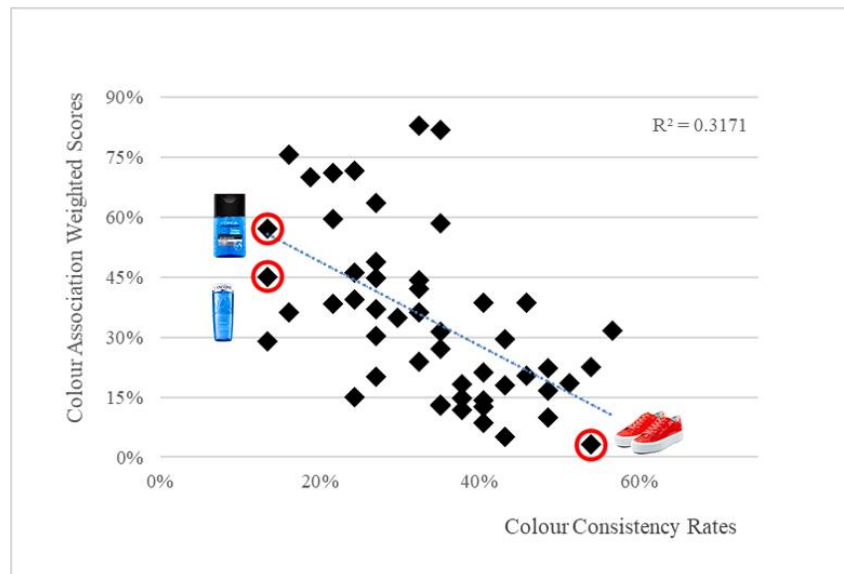


FIGURE 5.4.6 The correlation of the colour association scores with the colour consistency rate. Each filled diamond symbol represents one product (selected products are identified using an icon).

5.5 Discussions and Conclusions

The purpose of this study was to test whether consumers' colour associations affect their intended product-colour purchase decisions if they are given various colour choices. The work employed two research activities (an interview and a laboratory experiment) and two research methods (multiple choice for 6-alternative-forced-choice and multiple choice for rank-order) to investigate which colour a participant would choose if asked to select a product to purchase when there is a range of colours (six colours in this work) available and also need them to provide to reason for each product. This study was also designed to elicit a response about participants' colour preference and colour association for each colour. This section concludes the key insights and critique of research methods for this study, and also plans the next steps for the study. Colour is an important marketing tool for many products. Product-colour preference decisions are often connected with colour associations (Study II, CHAPTER 5),

product's performance/functionality (Study I, CHAPTER 4) or other factors depending on the type of products. These are referred to as primary factors, and it is also suggested that a consumer's personal colour preference may be important but only in the absence of these *primary factors* (*colour functionality, colour performance, colour association* etc.), that will otherwise drive purchase behaviours.

First of all, this study investigates whether consumers' individual colour preferences affect their product-colour purchase decision intentions. The data from Laboratory Experiment II suggests that of the products tested, participants are more likely to purchase a product-colour in their first favourite colour than their second to last favourite colour. However, the effect is much stronger for some products than for others and this was also found in a previous study, even more strongly than Study II (CHAPTER 4) (RQ 1).

This study identified five groups (classifications) about colour square associations (for six colours). There are Character (such as brave), Objective (such as oranges and lemons), Emotional Associations (such as passion and calm), Psychological (such as happy and warm) and Sensational associative (such as hot and cool) (RQ 2.1).

The work also explores whether the consumer's colour-square association affect their product-colour purchase choice intentions. In the interview, 35.22% reasons from product-colour purchase decisions were connected with colour-square associations. The results suggest that, for some of the products tested, participants are highly influenced by the colour association that they would purchase a product-colour on their one of the colour association than other colours (RQ 2.2 and RQ 2).

The second conceptual framework suggests that consumers' individual colour preferences are more likely to influence consumer product-colour purchase intentions in the absence of primary colour factors such as colour association factor (RQ 2.3), colour performance factor and colour functionality factor (the full framework is presented in FIGURE 5.2.2).

The study finds that individual colour preferences affect intended product-colour

purchase decisions but that the extent of this varies from one product category to the next. This work presents new experimental data about the role of colour in product or product packaging on intended consumer purchase decisions.

The second conceptual framework (FIGURE 5.2.2), supported by the experimental findings, further understands the relationship between individual colour preference and product-colour choice which more association aspects of colour itself (such as the associations of colour on a product).

It is noted that this work was concerned with that aspect of colour known as hue. However, it is acknowledged that lightness and chroma may also be important for consumer purchase decisions. The work in this study is also limited to understanding how to predict a consumer's product-colour decision (in other words, it is limited to understand when primary colour factor works on consumers' product-colour decision and vice versa). Finally, the work in this study is also limited to comparing the results from two research method (6-alternative forced-choice and rank-order) for colour preference test. It is clear that much more work is required in this field. TABLE 5.5 lays out the limitations for this study, the improvements and the objectives for continual studies, and the relevant chapters.

TABLE 5.5 Overview of limitations for Study II, and the improvements and the objectives for further studies, the relevant chapters are located.

Limitations	Improvements	Objectives	Chapter
- Limited to understand that how to predict consumer's product-colour decision;	- To test colour consistency rate by using different experimental conditions (such as different time conditions etc.);	- To <i>understand</i> when the primary colour factors influences consumers' product-colour decision and vice versa;	6
- Limited colour preference test data collection methods comparison (6-alternative forced-choice and rank-order);	- To test colour preference by using different methods (such as ranking, affective judgement, paired comparison etc.);	- To <i>explore</i> the accuracy of results between different research methods;	7

- Limited gender and culture comparison;	- To use other data collection activities (interviews) and to obtain different types of data (quantitative data);	- To <i>explore/explain</i> why the particular regularities occur;	7
- Concerned with the aspects of colour as hue only.	- To add lightness and chroma into the colour aspects.	- To <i>explore</i> whether lightness and chroma may also be important for individual purchase decisions.	Further Research

6 CHAPTER SIX – THE EFFECT OF DECISION TIME-LENGTH CONDITION ON CONSUMER PRODUCT-COLOUR PURCHASE DECISION

‘Extrinsic product cues are used by consumers who are short of time, that is, when they are in a hurry. In these situations, consumers lack the opportunity to evaluate and compare products and the intrinsic product cues that take more time to assimilate.’

- Kauppinen-Räsänen (2014)

6.1 Introduction

CHAPTER 4 and CHAPTER 5 suggested that there are three types of primary factors (*colour performance, colour functionality and colour association*) which affect consumers’ product-colour purchase decisions, based on analysis of an online survey, two laboratory-based experiments and an interview. CHAPTER 2 concluded that consumers rarely have time to fully evaluate products and that product packaging plays a crucial role in communication with the consumer. Hence, consumers’ product-colour decisions may not stable when products are complex and/or there is limited time for the evaluation of products. However, very little work has been carried out to explore whether consumers make different product-colour choices for the same product in different *decision conditions* (especially for difference in the time available); in other words, how the decision *time length* affects the role of colour factors product-colour choice. Critically, Study III *explores* whether the time consumers have to make decisions affects their product-colour decisions and whether the decision time-length

influences the impact of colour factors on consumers' product-colour choices. Strictly, in common with much of the work in this thesis, Study III is about *intended* purchase decisions, which may or may not translate into actual consumer purchases.

As described in CHAPTER 3, this work employs three research activities (two sets of online surveys and one set of laboratory experiments) to investigate which colour a participant would choose if asked to select a product to purchase given a range of available colours in different decision-making time conditions (referred to as *short-time* and *long-time*). These three activities were also designed to elicit a paired response about colour preference from each participant (twice for each product) in two decision-making time-conditions. The third framework presents a new *factor influence element* for *decision condition* working on consumer's product-colour decisions with colour factors (this framework is described in the following section). A conceptual framework captures the relationship for the stability of consumers' product-colour choices for different *decision conditions*; and explores the impact of colour factors on consumers' product-colour decisions in different *decision time-lengths*.

6.1 Introduction					
6.2 Research Design for Study III	6.2.1 Research questions, strategies and activities for Study III	6.2.2 Research hypotheses and framework for Study III			
6.3 Experimental Configuration	6.3.1 Experimental samples preparation	6.3.2 Data collection: Online Survey II and III, Laboratory Experiment III and IV	6.3.3 Participants recruitment and experiments procedure	6.3.4 Data analysis	
6.4 Results for Study III	6.4.1 Experimental Sequence	6.4.2 Correlation between decision time-length and product-colour stability	6.4.3 Experimental environment: online and laboratory	6.4.4 Product-colour consistency in different time-conditions	6.4.5 Correlation between product-colour consistency and time increasing
6.5 Discussions and Conclusions	6.5.1 Key insights for Study III	6.5.2 Critique for Study III and the next step			

FIGURE 6.1 Structure for CHAPTER 6.

This chapter consists of six sections. Section 6.1 summarises the achievement of this chapter. Section 6.2 presents the research questions, objectives and the third framework.

Section 6.3 outlines the experimental configuration for this study. Section 6.4 displays the key findings according to the research questions. Section 6.5 reflects upon the results and the critically evaluates the research methods, before outlining further directions.

6.2 Research Design for Study III

The research design for this work consists of research questions, research strategies, research activities, research hypotheses and a framework.

6.2.1 Research questions, strategies and activities for Study III

In Study III, one main research question (RQ 3) and three sub-research questions (RQ 3.1, RQ 3.2 and RQ 3.3) were translated into the purposes for this chapter: 1) to *explore* whether decision conditions affect consumers' product-colour choices; 2) to *explore* whether the length of decision time affects the stability of consumers' product-colour choices; 3) to *explore* the relationship between the consumers' product-colour consistency rates and the length of shopping time; 4) to *explore/explain* whether experimental sequence influences the research result in different time-length condition. An Abductive research strategy has been chosen to collect *Quantitative* type data. Two sets online surveys (Online Survey II and Online Survey III) and two laboratory experiments (Laboratory Experiment III and Laboratory Experiment IV) have been conducted (details see TABLE 6.2.1).

TABLE 6.2.1 Research questions, strategies and activities for Study II.

Research Question	Purpose	Research Strategy	Research Activity
RQ 3: Whether the decision conditions affect consumers' product-colour choices?	-To <i>explore</i> whether the decision conditions affect consumers' product-colour decisions;	Abductive Strategy (Quantitative	Two sets Online surveys

RQ 3.1: Whether the length of decision time affects the stability of consumers' product-colour decision?	-To <i>explore</i> whether the decision condition affects the stability of consumers' product-colour choices;	Data Type)	(Online Survey II and III) +
RQ 3.2: What is the relationship between the product-colour consistency rate and the length of shopping time?	- To <i>explore</i> the relationship between the consumers' product-colour consistency rates and the length of shopping time;		Two Laboratory Experiments (Laboratory Experiment III and IV)
RQ 3.3: Whether experimental sequence and environments influence the research result in different time-length condition?	-To <i>explore/explain</i> whether experimental sequence influence the research result in different time-length condition.		

6.2.2 Research hypotheses and framework

A previous conceptual framework (see CHAPTER 5, FIGURE 5.2.2) identified the effect of *individual colour preference* as secondary to primary factors (*colour functionality, colour performance, and colour association*) on consumer product-colour preferences in a normal condition. Some product-colour choices are highly related to primary factors, but for other products (in the absence of these factors) individual colour preferences may drive product-colour choices. However, the influence of these factors (primary colour factors and individual colour preference) on consumers' product-colour choices is uncertain. Here, the *factor influence element*, which influences the extent of colour factors working on consumer's product-colour decisions, is introduced. In this work, *decision condition* has been suggested as one of the factors influence elements. The updated hypothesis is that the *decision conditions* (time-restricted or non-time-restricted decision conditions in this research) affects the stability of consumers' product-colour decisions; additionally, that there is a variable relationship between *individual colour preference* and *primary colour factors* in various *decision-time-length* conditions. For example, consumers may be more likely to purchase a product with the colour they prefer in the short-time decision-making condition (where they are more

influenced by individual colour preference factor); and consumers may be more influenced by primary factors in the long-time decision-making condition. In other words, consumers may pay more attention to primary factors (colour functionality, colour performance, colour association etc.) when they have sufficient time to make a decision. The research describes both online and laboratory data for 20 products and explicitly tests the hypothesis that decision-time-length might be an element working on colour factors for consumers' product-colour choices (for details see FIGURE 6.2.2).

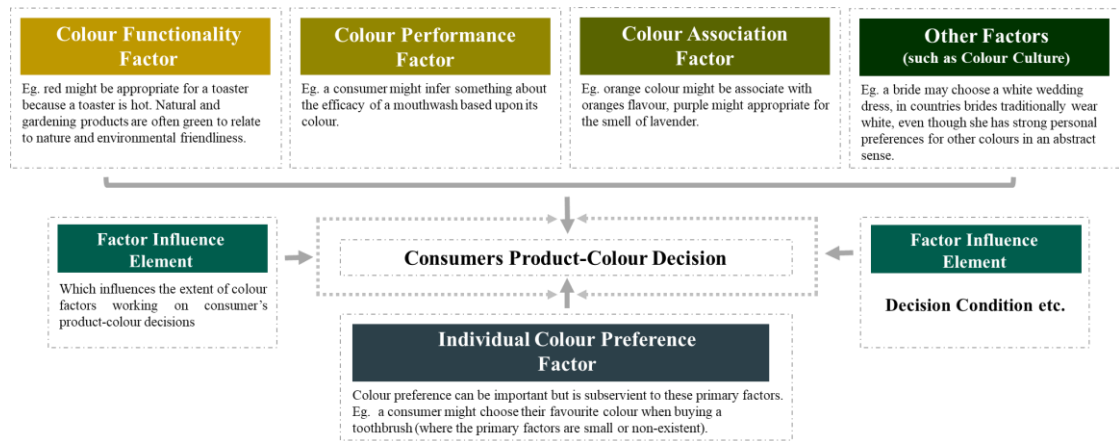


FIGURE 6.2.2 Framework for Study III.

6.3 Experimental Configuration

The experimental configuration consists of sample preparation, data collection method, participant recruitment and experimental procedure, and data analysis.

6.3.1 Experimental samples preparation

In this study, six colour squares (red, orange, yellow, green, blue and purple) were used (see Section 3.5.1.1). Twelve products were selected (see TABLE 6.3.1) which had a low colour consistency rate in Study II. In other words, consumers' product-colour purchase decisions for these 20 products were slightly influenced by individual colour preference factor, but more so by the primary factors (*colour functionality, colour performance, colour association* etc.). Products with a low colour consistency rate were

chosen so that there would be scope for an increased effect of individual colour preference in the short-time condition. Each of the 20 products was digitally manipulated in Adobe Photoshop to create images in each of the six colours. Appendix E.1 shows the full coloured images for 20 products. The CIELAB colour coordinates and the colour variability images for Study III have been shown in Appendix B.2.

TABLE 6.3.1 The 54 products used in Study III.

List of products					
Calculator	Candy	Cheese	Cream	Dental Floss	Deodorant
Hand Cream	Hand Wash	Ice Cream	Laundry Detergent	Make Up Remover	Washing Up Liquid
Shave Splash	Soap Bar	Table Cleaner	Toner	Toothpaste	Vase
Milk	Yoghurt				

6.3.2 Data collection: Online Survey and Laboratory Experiment

Three research studies (two sets of Online Surveys and one set of Laboratory Experiments) were employed for this study to investigate the effect of decision conditions on consumers' product-colour preferences. In each of the three studies, participants were asked to complete two surveys separated by two weeks. In each pair of surveys, the participants' decisions were either time-restricted (forced to respond within 4 seconds) or non-time-restricted (details see TABLE 6.3.2).

TABLE 6.3.2. Details of the three studies.

Studies	Research activities	Time between surveys	Controlled environment	Number of participants
Online Survey I (Group I)	1) Time-restricted online survey I 2) Non-time-restricted online survey I	Two Weeks	No	20
Online Survey II (Group II)	1) Non-time-restricted online survey II 2) Time-restricted online survey II	Two Weeks	No	20
Laboratory Experiment III and IV (Group III)	1) Time-restricted laboratory experiment 2) Non-time-restricted laboratory experiment	Two Weeks	A dark laboratory with professional display	24

6.3.2.3 Experimental structure

Three sets of research activities (see FIGURE 6.3.2.1 and TABLE 6.3.2) were employed for Study III. The order of the surveys (time-restricted or non-time-restricted) was different in the two Online surveys. In Online Survey I, participants completed the time-restricted survey first, then the non-time-restricted survey two weeks later and vice versa in Online Survey II. The research also explores the influence for where the experimental work takes place or the research environment (online or laboratory / non-restrict or a dark laboratory with professional display) and the experimental order (time-restricted decision environment first or non-time-restricted environment first). In Laboratory Experiments III and IV, participants undertook the time-restricted experiment in the first test.

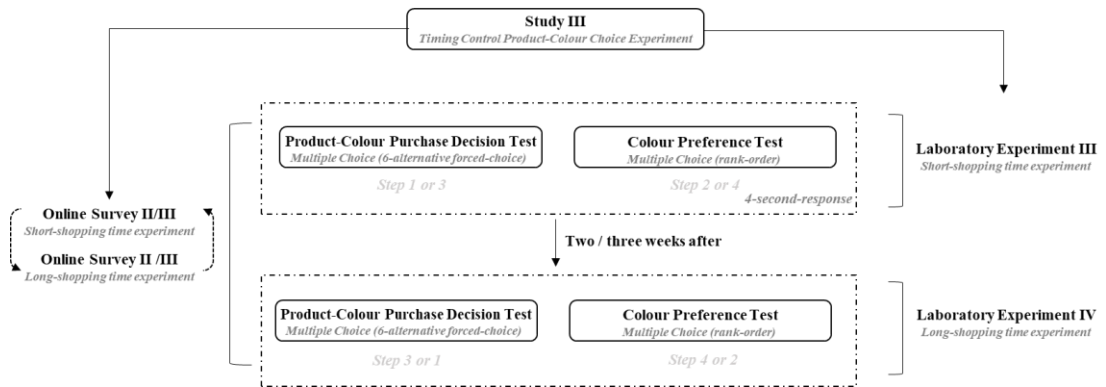


FIGURE 6.3.2.1 The experimental structure for Study III.

6.3.2.4 Online Survey II and III

The online surveys were made and launched by WJX.CN through a web page. The 6-AFC and rank-order research methods were employed with product-colour purchase decisions and individual colour preference questions. For the product-colour preference study, the six coloured images were simultaneously presented for each product in turn (the order in which the products were presented varied randomly for each participant) and asked to indicate which of the coloured products they would like to purchase. Additionally, in the time-restricted online surveys, if a participant did not respond in

four seconds, the survey would move to the next question automatically. The time remaining for each question was shown in the left-hand corner (see FIGURE 6.3.2.2).

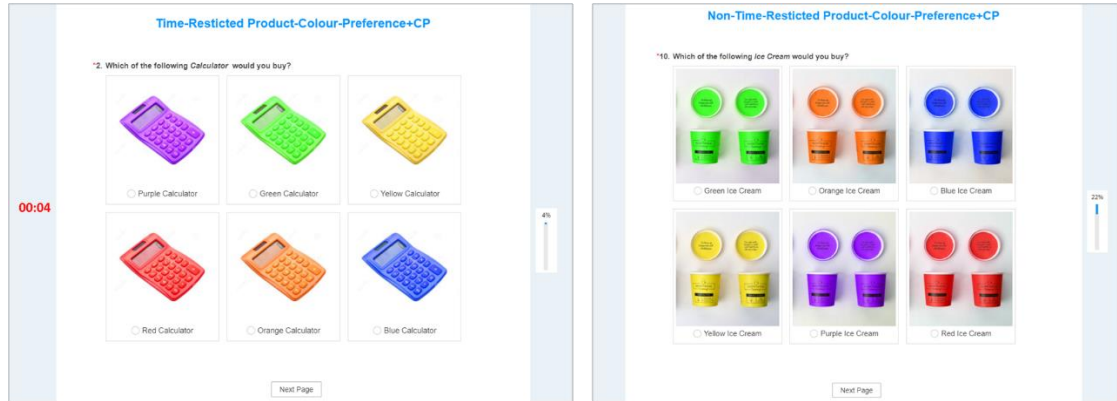


FIGURE 6.3.2.2 The interface of Online Survey II and Online Survey III. The order of Product-colour Choice Test in which the products were presented randomly for each participant. In the time-restricted online surveys, time was shown in the left hand side.

6.3.2.5 Laboratory Experiment III and IV

The laboratory experiments were made and coded using MATLAB (the response time length is recorded for all questions). For Laboratory Experiment III, in the time-restricted experiment participants were also asked to respond within four seconds, after which the buttons A to F would disappear (see FIGURE 6.3.2.3). In this situation, participants only could click the 'NEXT' button to turn to the next question, the 'Time' is shown beyond the 'NEXT' button. At the end of each experiment, the six coloured squares were displayed, and the participants were asked to indicate individual colour preference using a rank-order method (the participants clicked on each colour in order of preference, same structure as Study II, Laboratory Experiment II). In all tests, any missing answer were not recorded as any colour.

Before beginning Laboratory Experiment III (time-control), participants were given a training test to confirm that they could respond within four seconds. Some preliminary experiments were carried out with different time controls. The experiment needs to put the participant under time pressure; however, with time controls of less than 4s it was

found that the frequency at which participants didn't make a response was too high and therefore 4s was chosen as optimal time control.



FIGURE 6.3.2.3 Graphical user interface for Laboratory Experiment III (consists of Product-Colour Purchase Decision Test and Colour Preference Test). The order of Product-colour Choice Test and Product-Colour Performance/Functionality Test in which the products were presented randomly for each participant.

6.3.3 Participants recruitment and experiments procedure

In both Online Survey II and III, 20 participants were recruited (10 males and 10 females) for each set of surveys. The Laboratory experiments took place in a dark room in the Experience Design Laboratory at University of Leeds. A total of 24 participants were recruited to take part, comprising of 12 males and 12 females (all participants were students or staff at the University of Leeds). The experimental setting is shown in CHAPTER 4, FIGURE 4.3.3.

6.3.4 Data analysis

Five data analysis methods were used in this study. The Pearson Correlation Test and Paired-Sample T-Test were used to test for the statistical significance ($p < 0.05$) of the effect of decision-making time conditions (time control and non-time control) on consumers' product-colour consistency data. The Stability Test was used to investigate whether the length of decision-making time affects the stability of consumers' product-colour decision. The R-Squared Test was employed to identify the relationship between the length of decision-making time and product-colour consistency rate. TABLE 6.3.4

lays out the details of research activities, research methods, data analysis and objectives for this study.

TABLE 6.3.4 The experimental details and data analysis methods for online survey sets and laboratory experiments used for this study.

Research activities	Research methods	Data types	Data analysis	Objectives
Online Survey II	Multiple Choice (6-Alternative)	Quantitative Data	Independent Samples T-Test	-To explore whether the length of shopping time affects consumers' product-colour decisions;
+			Paired Sample T Test	-To explore whether the decision condition affects the stability of consumers' product-colour choices;
Online Survey III			Descriptive Statistic	
Laboratory Experiment III			Spearman's Correlation Test	- To explore the relationship between the consumers' product-colour consistency rates and the length of shopping time;
+	Laboratory Experiment IV		R-Squared Test	-To explore/explain whether experimental sequence / experimental environments influence the research result in different time-length condition.
Laboratory Experiment IV				

6.4 Results for Study III

This section consists of experimental sequence and experimental environment results, the correlation between decision time-length and product-colour stability results, the product-colour consistency in different time-conditions, and Correlation between product-colour consistency and time increasing results

6.4.1 Experimental Sequence

The effect of different experimental sequence was considered from the two Online Surveys. A test for statistically significance was carried out using the Independent Samples T-Test to investigate whether the experimental sequence has a significant influence on participant's product-colour decision stability results. Pairwise

comparisons between *the stability score* for participants' product-colour choices from Group I and Group II were carried out (*the stability score* is the extent to which the chosen product-colour from first survey matches the chosen product-colour from the second survey is calculated as a per cent figure). It was found that there was no statistical significance between two experimental sequences ($p=0.597>>0.05$, see TABLE 6.4.1) for the stability of participants' product-colour choices (RQ 3.3).

TABLE 6.4.1 Statistical analysis of experimental sequence by using Independent Samples T-Test different experimental sequence for Group I and II.

Independent Samples T-Test										
Levene's Test for Equality of Variances				t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Stability	Equal variances assumed	0.492	0.487	-0.533	38	0.597*	-0.0243	0.04564	-0.1167	0.0681
	Equal variances not assumed			-0.533	36.466	0.597	-0.0243	0.04564	-0.1168	0.0682

6.4.2 Correlation between decision time-length and product-colour stability

In the laboratory experiment (in both tests), the response-time for each question was recorded. The average response-time for the time-restricted test is 2.43 seconds, and for the non-time-restricted test is 5.98 seconds. In FIGURE 6.4.2 (a), the vertical and horizontal axes represent the length of product-colour decision time and participants' information respectively. Green areas represent the response-time from time-restricted test, and red areas represent the *decision increasing time* from time-restricted test to non-time-restricted test (in other words, each column represents the response-time from non-time-restricted test for each participant).

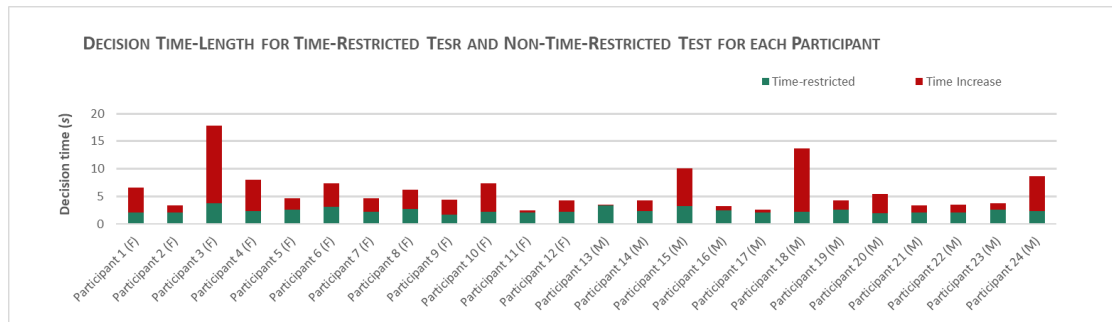


FIGURE 6.4.2 (a) The length of product-colour decision time from time-restricted test to non-time-restricted test for each participant. Green bars represent the time length for time-restricted test, each column (green bars add red bars) represent the time length for non-time-restricted test.

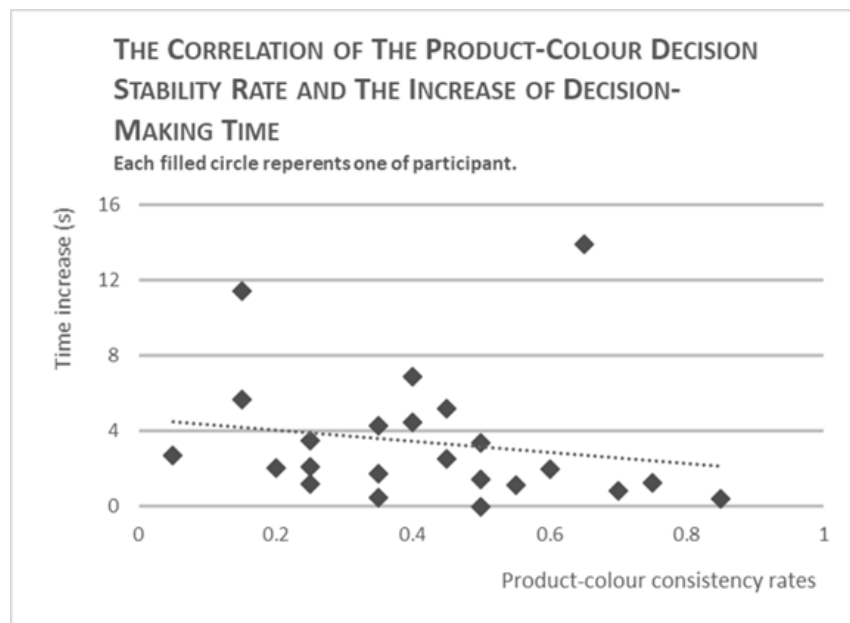


FIGURE 6.4.2 (b) The correlation of product-colour decision stability rates and the decision increasing time (each point on the graph refers to one participant).

One of the hypotheses is that consumers may have more stable product-colour choices in a long-time decision-making (shopping) condition rather than a short-time decision-making (shopping) condition. If thesis supported, between time-restricted test and non-time-restricted test, the expectation is a high increase of decision-making time to be

associated with a low product-colour decision stability rate. FIGURE 6.4.2 (b) shows a weak negative correlation between the decision increasing time (seconds) and product-colour decision stability rates (RQ 3.1). The vertical and horizontal axes represent the increase of decision-making time (seconds) and product-colour decision stability rates respectively.

Due to the non-normal distribution of the increase of decision-making time data ($\text{sig.}=0.046<0.05$), the Spearman's Correlation statistical analysis has been used (TABLE 6.4.2). There is a significant correlation ($\text{sig.}=0.36<0.05$) with -0.43 correlation coefficient, note that this is a negative correlation. That may suggest even for different participants, the longer they take to make their decisions, the lower the product-colour stability rate (RQ 3.1).

TABLE 6.4.2 Spearman's Correlation statistical analysis of product-colour decision stability rates and the increase of decision-making time.

Spearman's Correlations				
Spearman's rho	Time_Increase		Time_Increase	Stability_Rates
		Correlation Coefficient	1.000	-.430*
		Sig. (2-tailed)	.	.036
		N	24	24
	Stability_Rates			
		Correlation Coefficient	-.430*	1.000
		Sig. (2-tailed)	.036	.
		N	24	24
* Correlation is significant at the 0.05 level (2-tailed).				

6.4.3 Experimental environment: online and laboratory

Considering the influence of experimental environments (online or in the laboratory), two Independent Samples T-Test was carried out by using 64 sets of *product-colour consistency rates* (comparison of 40 sets of online and 24 sets of laboratory results in time-restricted and non-time-restricted conditions). No statistical significance was found between the two experimental environments ($p=0.051>0.05$ for time-restricted condition; $p=0.159>0.05$ for non-time-restricted condition) for participants' product-

colour consistency in both time conditions (see TABLE 6.4.3 (a) and TABLE 6.4.3 (b)). In other word, the experimental environment in this study is not a significant influence element to results. Over all, there is no statistically significant effect of experimental sequence (both in time-restricted and non-time-restricted test first) or experimental locations (online or in the laboratory) (RQ 3.3).

TABLE 6.4.3 (a) Statistical analysis of experimental environment by using Independent Samples T-Test for two time-restricted conditions.

Independent Samples T-Test										
Levene's Test for Equality of Variances				t-test for Equality of Means						
				95% Confidence Interval of the Difference						
F Sig.				t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Time_restriction_colour_consistency	Equal variances assumed	0.106	0.746	-1.988	62	<u>0.051</u>	-0.026	0.013	-0.052	0.0001446
	Equal variances not assumed			-1.999	49.395	0.051	-0.026	0.013	-0.052	0.0001366

restricted were 35% and 26%. This suggests that participants prefer to choose a product with their first preferred colour in short-time decision-making conditions rather in long-time conditions. This result is found for both studies. For each group (two online groups and a laboratory group), in the short-time decision-making condition, participants tend to choose a product with the colour they more preferred. Additionally, the product-colour-consistency rate treated as rank-order for time-restricted and non-time-restricted were 35% and 26% (1st preferred colour); 17% and 19% (2nd preferred colour); 14% and 14% (3rd preferred colour); 14% and 18% (4th preferred colour); 10% and 13% (5th preferred colour); and 9% and 10% (6th preferred colour). This suggests that participants may prefer to purchase a product with their preferred colour, both in short-time and long-time decision conditions. In other words, individual colour preference factor does affect participants' product-colour decision further (see FIGURE 6.4.4).

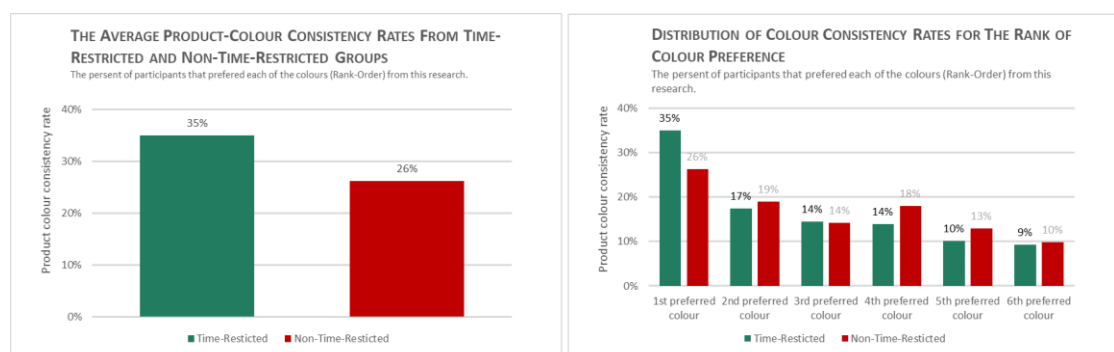


FIGURE 6.4.4 Distribution of colour consistency rates for the rank of colour preference.

To test the influence of decision-time-length on colour preference factor, a test for statistical significance was carried out using Paired-Sample T-Test. The Paired-Sample T-Test is used to compare two different time conditions of measurement where the measurements are applied to the same products (20 products for 64 participants). Pairwise comparisons (each participant-pair for each product) were carried out for product-colour consistency rates. It was found that there was a statistically significant difference (Sig. (2-tailed) = 0.008 << 0.05) between time-restricted and non-time-restricted conditions for product-colour consistency rates (see TABLE 6.4.4). In other

words, the decision-time condition is an *effect element* which influences role of the colour preference factor on consumers' product-colour decisions (RQ 3).

TABLE 6.4.4 Statistical analysis of decision-time conditions by using Paired-Samples T-Test for time-restricted and non-time-restricted conditions.

Paired Sample T Test									
Paired Differences									
95% Confidence Interval of the Difference									
		Mean	Sig. Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair	Time_restrict - Non_time_restrict	.0133	.0391	.0049	.0036	.0231	2.724	63	<u>.008</u>

6.4.5 Correlation between product-colour consistency and the difference in time taken

In the laboratory experiment, the average product-colour consistency rates for time-restricted test and non-time-restricted tests were 35% and 26%. Thirteen products showed positive changes in product-colour consistency rates; on the other hand, five products showed negative changes (see FIGURE 6.4.5 (a)). This suggests that consumers may tend to purchase the product-colour as their preferred colour when they were in the short-time decision-making condition (or, as we say, in a hurried shopping condition). In other words, consumers may be more likely to purchase a product with the colour they prefer in the short-time shopping condition.

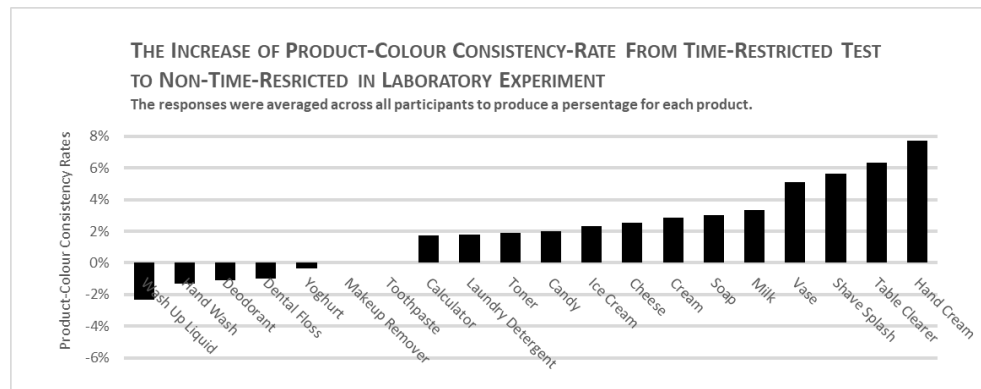


FIGURE 6.4.5 (a) The increase of product-colour consistency rates from time-restricted test and non-time-restricted test for every product in the laboratory experiment.

The critical observation is that the product-colour consistency rate correlates with the length of product-colour decision-making time for the product. If the conceptual framework (FIGURE 6.2.2) is supported, the expectation is that a high increase of selection time to be associated with a high increase of product-colour consistency rates and vice versa. In FIGURE 6.4.5 (b), the vertical and horizontal axes represent the correlation of the increase of decision-making time with the increase of product-colour consistency rate, between Laboratory Experiment III and Laboratory Experiment IV (each filled circle represents one product). The coefficient of determination (r^2) between product-colour association scores and product colour consistency rate is 0.03 (RQ 3.2).

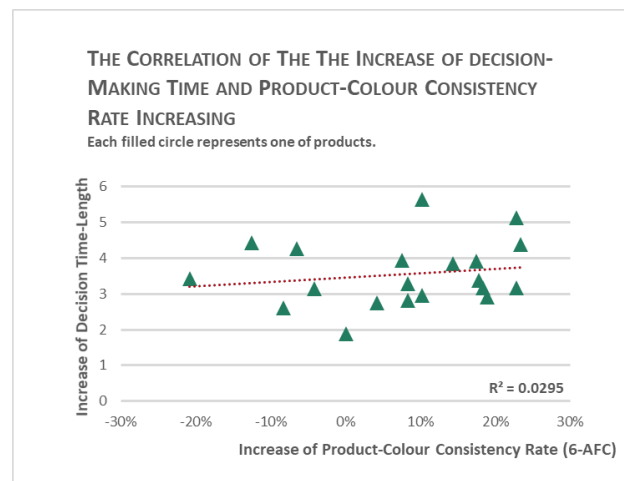


FIGURE 6.4.5 (b) The correlation of the increase of selection time with the increase of product-colour consistency rate from Experiment III and Laboratory Experiment IV. Each filled circle represents one product.

6.5 Discussions and Conclusions

The purpose of this study was to test whether the length of shopping time affects the stability of consumers' product colour decisions; and whether the shopping-time (decision time-length) influences the impact of primary factors on consumers' product-colour decisions. The work employed three research activities and two research methods with visual component to investigate which colour a participant would choose

if asked to select a product to purchase when there is a range of colours (red, orange, yellow, green, blue and purple) available, and two time-condition (short-time and long-time) provided to this research. This section concludes the key insights and critique of research methods for this study, and also plans the next steps for the research.

Products present with expected or preferential colours and colour schemes. Product-colour preference decisions are often connected with consumers' colour associations (Study II, CHAPTER 5), a product's performance/functionality (Study I, CHAPTER 4), other factors depending on the type of product, or consumers' length of shopping-time (Study III, CHAPTER 6). *Decision conditions* has been introduced as a new *factor effect element* to build the framework further, *decision time-length* has been tested in this research.

First of all, the data from two online studies suggests that the experimental sequence has no significant influence on the stability of participants' product-colour choices (time-restricted or non-time-restricted first). Also, there is no significant difference between experimental environments (online or laboratory experiment) (RQ 3.3).

The data from the laboratory experiment suggests consumers may have more stable product-colour choices in a long-time decision-making (shopping) condition rather than in a short-time decision-making (shopping) condition (see FIGURE 6.4.2 (b)) (RQ 3.1). This research also further investigates whether consumers' individual colour preference affects their product-colour purchase intentions. The data from three studies show that for the products tested, participants are more likely to purchase a product-colour in their first favourite colour than their second to last favourite colour in both time conditions (long-time or short-time decision-making conditions) (RQ 3).

The new conceptual framework may suggest that consumers' product-colour choices are significantly different in different time conditions. In other words, the impact of colour factors on consumers' product-colour intentions may change in different time conditions. Consumers may be influenced more by colour preference factor in the short-time shopping condition (the full framework is presented in FIGURE 6.2.2) (RQ 3.2).

The study finds that the length of shopping time does affect the stability of consumers' product colour decision, also suggests that consumer might make a different product-colour decision when they are in a difference shopping-time condition. However, the correlation of the increase of selection time with the increase of product-colour consistency rate is really weak ($r^2=0.03$, from Experiment III and Laboratory Experiment IV), cause that only 24 participants took part in laboratory. It is clear that much more work is required in this field. Finally, the third conceptual framework (FIGURE 6.2.2) noted that this work was concerned with that aspect of colour known as hue. However, it is acknowledged that lightness and chroma may also be important for consumer purchase decisions. TABLE 6.5 lays out the limitations for this study, the improvements and the objectives for continual studies, and the relevant chapters.

TABLE 6.5 Overview of limitations for Study III, and the improvements and the objectives for further studies, the relevant chapters are located.

Limitations	Improvements	Objectives	Chapter
- Limited gender and culture comparison.	- To group participants in different gender and culture group;	- To explore the differentiation/agreement between different gender and culture;	7
- Concerned with extra participants.	- To invite additional participants, take part in laboratory experiments.	- To further explore the relationship between decision conditions and consumers' product-colour choices	Further Research
- Concerned with other factor influent elements.	- To expend the framework.	- To further understand other elements which influence colour factor working on consumer's product-colour decisions	Further Research
- Concerned with the aspects of colour as hue only.	- To add lightness and chroma into the colour aspects;	- To explore whether lightness and chroma may also be important for consumer purchase decisions.	Further Research

7 CHAPTER SEVEN – DESIGN OF A FRAMEWORK FOR A FURTHER ANALYSIS

‘Public and private actions that alter the way in which people live, work, play, relate to one other, organise to meet their needs, and generally cope as members of society. Cultural (and gender) impacts involve changes to norms, values, and believes of individuals that guide and rationalise their cognition of themselves and their society.’

-Budge and Vanclay (1996)

7.1 Introduction

Study I (CHAPTER 4), Study II (CHAPTER 5) and Study III (CHAPTER 6) all provided evidence to support the idea that individual colour preferences affect participants’ purchase decisions (or, at least, their intended purchase decisions). In Study I and II it was also suggested that there are three types of primary factors (*colour performance*, *colour functionality* and *colour association* factors) which affect consumers’ product-colour decisions. Although primary factors usually dominate personal colour preferences, the data in Study III suggested that consumer personal colour preferences may be more likely to influence consumer product-colour purchase intentions in short-time decision-making conditions.

However, gender and nationality differences in individual colour preference and product-colour decisions are less known (affected by primary factors and time-conditions). It was noted in CHAPTER 2 that the effect of differences in research methods and research environments on colour preference research are also less established. In this chapter, two main research aims and six sub-research aims are achieved (details are described in section 7.2). The research is based on six research

activities (from Studies I, II and III) for further analysis.

This chapter consists of five sections. Section 7.1 summarises the achievement of this chapter. Section 7.2 outlines the research plan including research questions, research objectives and a framework. Section 7.3 outlines the colour preference responses by different groups to explore the effect of research methods, genders and nationalities etc. Section 7.4 displays the key findings for different genders according to the research questions. Section 7.5 reflects upon the results and critically evaluates the research methods.

7.1 Introduction					
7.2 Research Design for CHAPTER 7	7.2.1 Research questions, strategies and activities for CHAPTER 7	7.2.2 Framework for the meta- analysis and data analysis methods			
7.3 Colour Preference Response by Groups	7.3.1 Colour preference response by different research environments	7.3.2 Colour preference response by different colour preference research methods	7.3.3 Monte Carlo analysis for individual colour preference	7.3.4 Colour preference response by gender	7.3.5 Colour preference response by nationality
7.4 Response Difference by Gender	7.4.1 Gender difference on product-colour consistency	7.4.2 Gender difference on colour association	7.4.3 Gender difference on product-colour reason	7.4.4 Gender difference on the connection between colour association and product- colour reason	7.4.5 Gender difference in the product-colour decision time length Pg X
7.5 Discussions and Conclusions for CHAPTER 7	7.5.1 Key insights for CHAPTER 7	7.5.2 Critique of for CHAPTER 7			

FIGURE 7.1 Structure for CHAPTER 7.

7.2 Research Design for CHAPTER 7

The research analyses data from eight research activities and three research methods from Studies I, II and III (details see TABLE 7.2). This section lays out research questions, research aims, research objectives, a framework for the meta-analysis and data analysis methods.

TABLE 7.2 Further analysis for eight research activities from three studies for CHAPTER 7.

Study	Research activity	Research environment	Colour preference method	Decision condition	Data Type
Study I	Online Survey I	Online	6-AFC	*	Quantitative
	Laboratory Experiment I	Laboratory	6-AFC	*	Quantitative
	Interview	Laboratory	*	*	Qualitative
Study II	Laboratory Experiment II	Laboratory	Rank-Order	*	Quantitative
	Online Survey II	Online	Rank-Order	Time-restricted	Quantitative
Study III	Online Survey III	Online	Rank-Order	*	Quantitative
	Laboratory Experiment III	Laboratory	Rank-Order	Time-restricted	Quantitative
	Laboratory Experiment IV	Laboratory	Rank-Order	*	Quantitative

7.2.1 Research questions, aims and objectives for CHAPTER 7

In CHAPTER 7, two main research questions and six sub-research questions were translated into research aims (TABLE 7.2.1). The aims were broken down into the following objectives:

TABLE 7.2.1 Research questions and objectives for CHAPTER 7.

Research Question	Purpose
RQ 4: How much agreement are the results of individual colour preference from different research strategies?	-To test the agreement of the results of individual colour preference from two research methods (multiple choice for 6-alternative forced-choice and multiple choice for rank-order) and two research environments (online and laboratory);
RQ 4.1: How much agreement are the results of individual colour preference from two research methods (6-alternative forced-choice and rank-order) and two research environments (online and laboratory)?	
RQ 4.2: Whether there are differences in individual colour preferences between different gender groups?	-To identify whether there are differences in individual colour preferences between different gender and nationality groups;
RQ 4.3: Whether there are differences in individual colour preferences between different nationality (cultural) groups?	
RQ 5: What are the relationships between colour preference, colour association, the length of shopping time and other factors when consumers purchase a colour of product between gender groups?	-To explore whether there are differences in product-colour consistency rates between different gender groups;

RQ 5.1: Whether there are differences in product-colour consistency between different gender groups?	-To investigate whether there are differences in colour associations and product-colour choosing reasons between different gender groups;
RQ 5.2: Whether there are differences in colour-associations and product-colour choosing reasons between different gender groups?	
RQ 5.3: Whether there are differences in product-colour decision-making time-length between different gender groups?	-To identify whether there are differences in product-colour decision-making time-length between different gender groups.

7.2.2 Framework for the meta-analysis and data analysis methods

Qualitative and quantitative data from the previous chapters are re-analysed in this chapter. Specifically, the further analyses described in this chapter uses the data from a large number of participants and products, and explicitly tests the hypothesis that different research methods may affect the personal colour preference results. Also, different gender/nationality groups may have slightly different results for the same research topic.

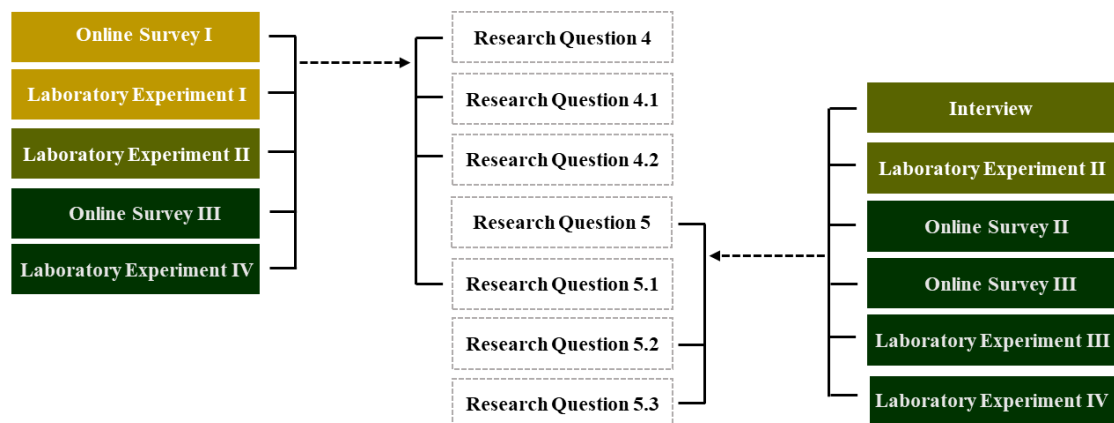


FIGURE 7.2.2 Framework for CHAPTER 7.

In the framework for analysis (illustrated in FIGURE 7.2.2) the data from five research activities (Online Survey I, Laboratory experiment I, Laboratory experiment II, Online Survey II and Laboratory experiment IV) were analysed to investigate the agreement of the results of colour preference from two research methods and different gender/

nationality groups. The data from six research activities' data (Interview, Laboratory experiment II, Online Survey II, Online Survey III, Laboratory experiment III and Laboratory experiment IV) was recruited to investigate the difference in product-colour consistency, the product-colour decision-making time length, colour-associations and product-colour choosing reasons between different gender groups.

TABLE 7.2.2 Data analysis methods in CHAPTER 7.

Research activities	Research methods	Data types	Data analysis	Objectives
Online Survey I + Laboratory experiment I + Laboratory experiment II + Online Survey III + Laboratory experiment IV	Multiple Choice (6-alternative forced-choice + Multiple Choice (rank-order)	Quantitative Data	Descriptive Statistic + R-Square Test + Z score Test + Chi-Squared Test for Independence + Monte Carlo Analysis + Independent T-Test	- To test the agreement of the results of colour preference from two research methods (6-alternative forced-choice and rank-order) and research environment (online and laboratory). - To identify whether there are differences in individual colour preferences between different gender and nationality groups. -To explore whether there are differences in product-colour consistency between different gender groups.
Interviews + Laboratory experiment II + Laboratory experiment III + Laboratory experiment IV	Semi-structured interview + Multiple Choice (6-alternative forced-choice	Qualitative Data + Quantitative Data	Template Analysis + Descriptive Statistic + R-Square Test	- To investigate whether there are differences in colour-associations and product-colour choosing reasons between different gender groups. - To identify whether there are differences in product-colour decision-making time length between different gender groups.

The Chi-Squared Test for Independence was used to test for the statistical significance ($p<0.05$) of the effect of gender/nationality/environment conditions (male/female, Chinese/UK and online/laboratory) on colour preference data; Monte Carlo analysis and z score are conducted to explore the level of agreement of the 6-AFC and Rank-Order methods to estimate scale samples; the Independent T-Test was employed to test

for the statistical significance ($p < 0.05$) for product-colour consistency between different gender groups; the R-Squared Test was recruited to test the agreement between two research methods (6-AFC and rank-order); Template Analysis was used to code qualitative data for differences in colour-associations and product-colour choosing reasons between different gender groups. TABLE 7.2.2 presents the details of the data analysis methods and objectives for this study.

7.3 Colour Preference Response by Groups

Colour preference responses were collected in all the research activities. Participants were presented with six differently coloured squares, which primarily differed in hue (red, orange, yellow, green, blue and purple, see Section 3.5.1.1). This section consists of individual colour preference response by different research methods (multiple choice for 6-alternative forced-choice and multiple choice for rank-order) and research environments (online and laboratory), individual colour preference response by genders (male and females) and individual colour preference response by nationalities (Chinese and UK).

7.3.1 Effect of research environment on colour preference

A test for statistical significance was carried out using the Chi-Square test of independence to investigate whether the experimental environmental factor has a significant influence on colour preference results. Pairwise comparisons between individual colour preference results from online and laboratory experimental environment were carried out (212 online 6-AFC responses and 101 laboratory responses only consider the colour was placed in the first choice). It was found that there was no statistical significance between two environments ($p = 0.556 > 0.05$) for individual colour preference (see TABLE 7.3.1) (RQ 4.1).

TABLE 7.3.1 Chi-Square Test of Independence result for individual colour preference by experimental environments (online and laboratory).

Independent Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.887 ^a	5	0.566
Likelihood Ratio	3.954	5	0.556
Linear-by-Linear Association	0.448	1	0.503
N of Valid Cases	313		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.38.			

7.3.2 Effect of research methods on colour preference

First, considering the data collection from different research methods, 313 responses were collected for 6-AFC method from Online Survey I, Laboratory experiment I, Laboratory experiment II, Online Survey III and Laboratory experiment IV (212 multiple choice for 6-alternative forced-choice responses and 101 multiple choice for rank-order responses). That is, only the colour that was placed chosen first was considered; the other choices were discarded; 101 responses were collected for rank-order method from Laboratory experiment II, Online Survey III and Laboratory experiment IV. In this section the ordinal rank and comparative data are converted to interval-data z scores.

For ease the frequency has been converted to a *per cent* value indicating the per cent of participants who selected each colour. The individual rank data from each participant were combined to mean rank data and subsequently proportion values (between 0 and 1) where the greater the value the greater the preference of the participants for the sample. The proportion values were converted to interval scale values z using the inverse of the cumulative standardized normal distribution according to case V of Thurstones Law of Comparative Judgement (Hohle, 1966). In order to compare two experimental methods, the interval scale values z have also been used on 6-AFC methods. There is a well-known problem in that calculating z is not possible when the proportions are exactly 0 or 1 (which can happen if all participants rank a sample as

most or least preferred, for example). In these cases, proportions of 0 and 1 are replaced with 1/999 and 999/1000 respectively which is standard practice (Westland *et al.*, 2014; Sanborn *et al.*, 2010).

The colour preference sequence for z value/scores for 6-AFC method were blue > red > orange > yellow > purple > green, which represents a similar colour-preference-rank with Rank-Order method (blue > red > orange > yellow > purple > green) (see FIGURE 7.3.2(a)). FIGURE 7.3.2(a) also shows the correlation between the individual colour preferences from the two research methods. The vertical and horizontal axes represent the individual colour preference percentages from rank-order method and 6-AFC method respectively. Each coloured point on the graph refers to one of the colours and it is evident ($r^2=0.9$) that there is an agreement between the data from the two methods (RQ 4).

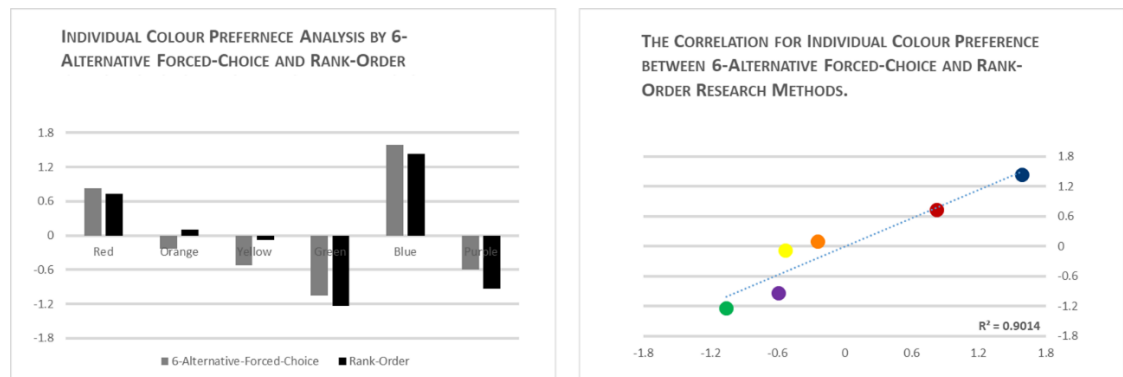


FIGURE 7.3.2(a) Individual colour preference Z value distributions and the correlation for colour preference between 6-AFC and rank-order research methods (6-AFC results come from Online Survey I and III, Laboratory experiment I, II and IV; Rank-Order result come from Online Survey III, Laboratory Experiment II and I.)

Reader might argue that the data from Fig. 4 were collected from a different population (two of the three experiments, the Online Survey I and Laboratory Experiment I, did not collect rank-order data). In order to reduce this differentiation, FIGURE 7.3.2(b) analyses the results from Laboratory Experiment II only. The colour preference Z value/scores for 6-AFC method were blue > red > yellow > orange > purple > green; for

Rank-Order method were blue > red > orange > yellow > purple > green which represent a similar colour-preference-rank (see FIGURE 7.3.2(b)). Also FIGURE 7.3.2(b) shows the correlation between the individual colour preferences from two research methods. The vertical and horizontal axes represent the colour preference percentages from rank-order method and 6-AFC method respectively. Each coloured triangle on the graph refers to a colour and it is evident ($r^2=0.82$) that there is still an agreement between the two methods' result (from the same experiments, RQ 4).

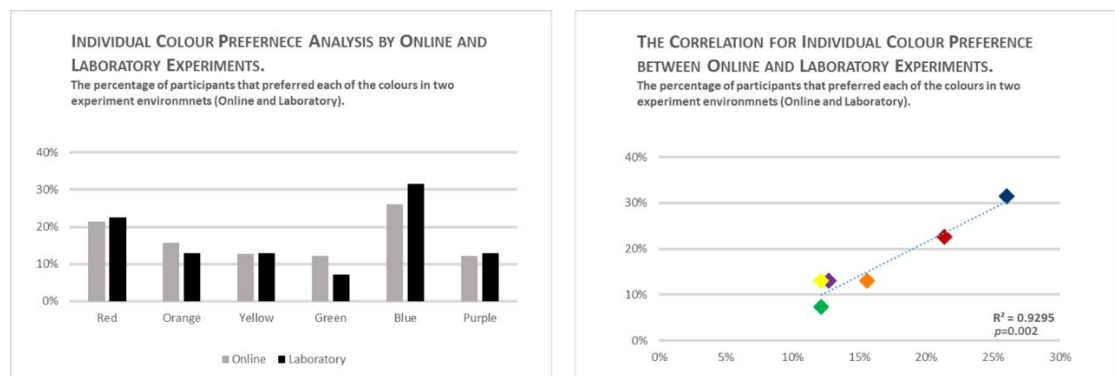


FIGURE 7.3.2(b) Individual colour preference z value distributions and the correlation for colour preference between multiple choice for 6-alternative forced-choice and multiple choice for rank-order research methods (all 6-AFC and rank-order results come from Laboratory Experiment II, Online Survey III and Laboratory Experiment IV).

7.3.3 Monte Carlo analysis for individual colour preference

This work seeks to explore the effect of experimental methods on the individual colour preference scale values (the relationships between experimental method factor and participants number factor). A Monte Carlo simulation conducted to explore the level of agreement of the 6-AFC and rank-order methods. In total 101 participants took part in Laboratory Experiment II. When responses from all 101 participants are considered the two methods' performance is similar. However, in practice many studies will use fewer participants; how robust will the methods be when the number of participants is reduced? In this work the data from the 101 people are sub-sampled. If use fewer than

85 participants, then the question is which ones should we include? A Monte-Carlo procedure is therefore necessary; we sub-sample the full population repeatedly taking a different sub-sample each time. The following four steps are used:

- 1) Subsample n of the data from *the 101* participants randomly where n is [100, 95, 90, 85, 80, 75, 70... 10, 5] (Step 1);
- 2) Calculate the individual colour preference for each of the n scale samples ($n = 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10$ and 5) and obtain the two distributions (from the two methods 6-AFC and rank order) of individual colour preference for each n scales (Step 2);
- 3) Construct the r^2 (correlation coefficient) calculated between the individual colour preference from all the data ($n = 101$) and from the sub-sampled data ($n = 75, 70, 65$ etc.) (Step 3, FIGURE 7.3.3(a) and FIGURE 7.3.3(b) illustrate an example for two methods, Step 3);
- 4) Compare the r^2 distributions between the two methods (Step 4, FIGURE 7.3.3(c));

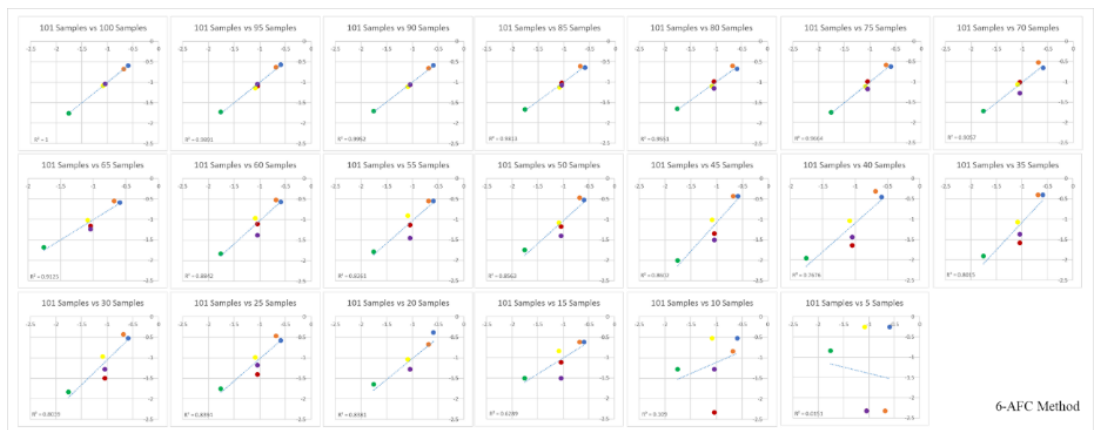


FIGURE 7.3.3(a) The correlation for the individual colour preference between using all of the data ($n=101$) and each the sub-sampled data ($n=100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10$ and 5) from the 6-AFC method (an example illustration for Step 3).

FIGURE 7.3.3(a), FIGURE 7.3.3(b) and FIGURE 7.3.3(c) are an example illustration for Step 3 and Step 4. The vertical and horizontal axes represent the correlation coefficient (r^2) values and n scale samples ($n=100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10$ and 5). In the FIGURE 7.3.3(c), the blue and red lines show the r^2 distributions form Rank-Order and 6-AFC methods (each point represents the correlation coefficient for each n scale samples). Compare the small-scale samples tests ($n=15, n=10$ and $n=5$), for Rank-Order method, the correlation coefficients hold on the high agreements ($r^2=0.9, r^2=0.82$ and $r^2=0.63$); for 6-AFC method, the correlation coefficients decrease sharply to the low agreement positions ($r^2=0.63, r^2=0.11$ and $r^2=0.05$).

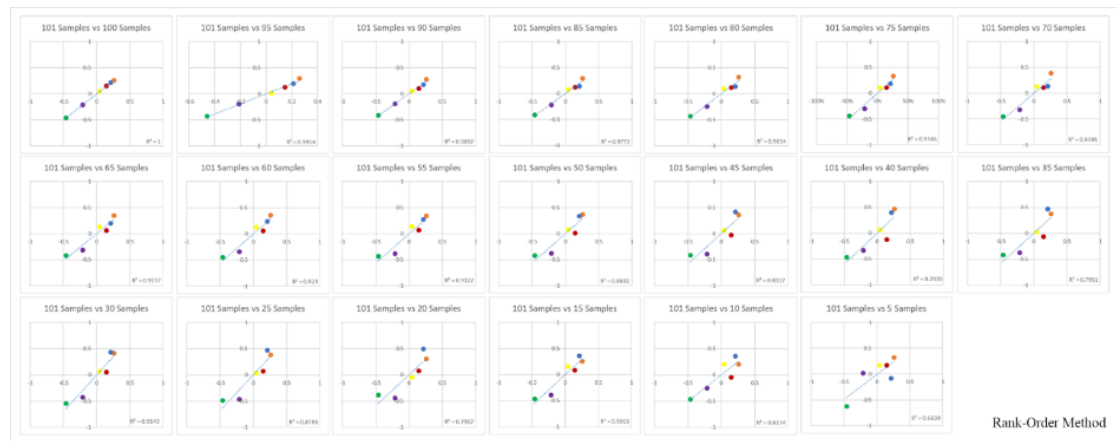


FIGURE 7.3.3(b) The correlation for the individual colour preference between all of the data ($n=101$) and each the sub-sampled data ($n=100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10$ and 5) from Rank-Order method (an example illustration for Step 3).

FIGURE 7.3.3(c) shows how robust each of the two methods are as the number of participants taking part in the experiment reduces. The experiment with 101 participants is assumed to be the correct data (the true scale values) and as the correlation (where $n < 101$) between the calculated scale values and the true scale values reduces the experiment is considered to be less robust. As can be seen in FIGURE 7.3.3(c), the rank-order method is more stable than the 6-AFC method. However, the sub-sampling was random and were the sub-sampling to be repeated there is no certainty that the same

result would occur.

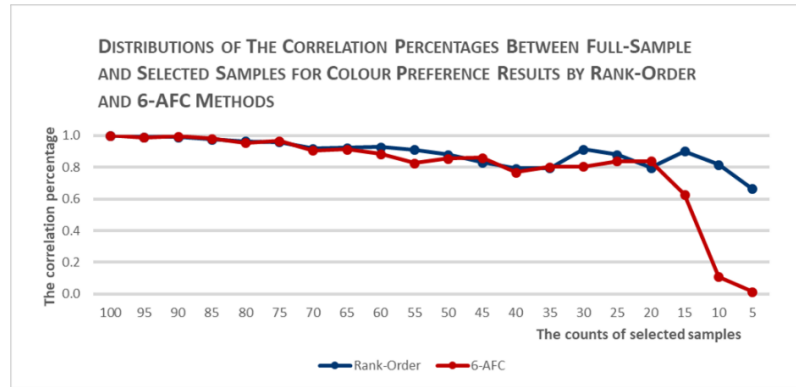


FIGURE 7.33(c) An example illustration for the correlation coefficient distributions form Rank-Order and 6-AFC methods. Each point represents the correlation coefficient for each n scale samples ($n=100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10$ and 5). The vertical and horizontal axes represent r^2 values and n scale samples.

In order to more fairly compare the stability of the two methods, the simulation was repeated 1000 times (the Monte Carlo), each time starting with a different random set of scale samples and the mean correlation coefficient (averages overall 1000 trials) was used as a measure of performance. In FIGURE 7.3.3(d), the vertical axes represent the correlation coefficient (r^2) values scales, and horizontal axes represents the n scale samples ($n=100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10$ and 5), each box plots represents a correlation coefficient for each n scale samples. FIGURE 7.3.3(d) displays the box plots for the r^2 distributions from 6-AFC (left image) and Rank-Order (right image) methods.

Notice that for both methods, taking $n=5$ as an example, it is evident that the Rank-Order method median (shown by the red horizontal line) is slightly higher than 6-AFC method ($r^2 \sim 0.25$ in 6-AFC method, $r^2 \sim 0.41$ in Rank-Order method). However, there is substantially more variation in 6-AFC method (shown by the line plots) which ranges between approximately from 0.72 (for $n=5$), whereas the Rank-Order method ranges approximately from 0.98. Furthermore, FIGURE 7.3.3(d) show that the *outliners* (red stars) from the 6-AFC methods are much more than in Rank-Order methods. Both of

these happens for most values of n . In other words, the results from Monte Carlo simulations show that the Rank-Order method is more stable than the 6-AFC method for individual colour preference when n is small. This suggests that, for studies involving small numbers of participants (participant factor), the rank-order method (experimental method factor) should be preferred (but that the choice of method becomes unimportant as the number of participants becomes large).

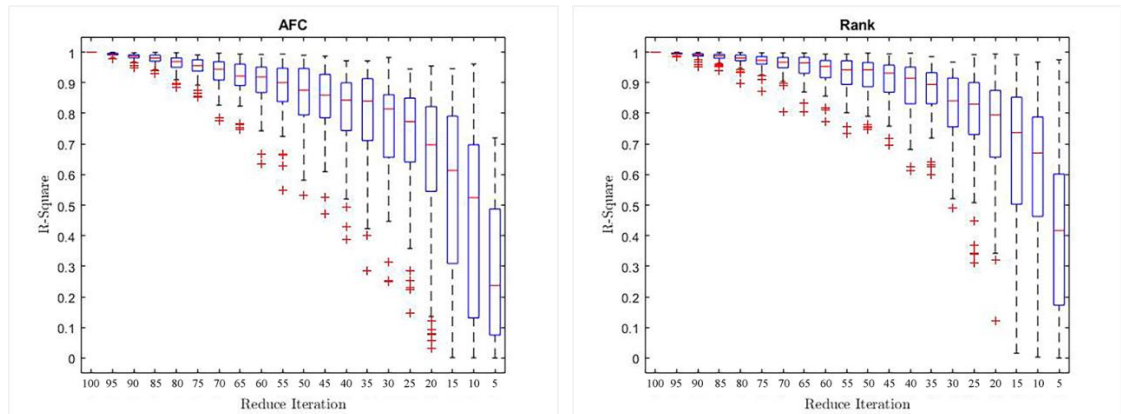


FIGURE 7.3.3(d) The box plots for the r^2 distributions from 6-AFC (left image) and Rank-Order (right image) methods.

7.3.4 Effect of gender on colour preference

In this section, 313 responses were collected by multiple choice for 6-alternative forced-choice method, a comparison of 125 males and 188 females.

FIGURE 7.3.4 displays the distribution and correlation for individual colour preference from males and females. The left image shows the preference scores for male were blue (38%), following by orange (21%), red (14%), green (14%), yellow (7%) and purple (6%); shows the preference scores for female were red (25%), following by purple (18%), blue (18%), yellow (17%), orange (17%) and green (7%). The two-descending order of individual colour preference from male and female (by 6-AFC) were: Blue > Orange > Red = Green > Yellow > Purple; and Red > Purple = Blue > Yellow = Orange > Green. It shows the correlation between the individual colour preferences from male and female. The vertical and horizontal axes represent the individual colour preference

percentages from rank-order method and 6-AFC method respectively. Each coloured point on the graph refers to one of the colours and it is evident ($r^2=0$) that there is no agreement between the data from the two methods.



FIGURE 7.3.4 Individual colour preference distributions and the correlation for colour preference between Male and Female participants.

A further test for statistical significance was carried out using the Chi-Squared Test for Independent. Pairwise comparisons between male and female colour preference were carried out, and it was found that there was a statistical significance between male and female ($p=0.000<<0.05$) for individual colour preference (see TABLE 7.3.4) (RQ 4.2).

TABLE 7.3.4 Chi-Square Test of Independence result for individual colour preference by genders.

Independent Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.545 ^a	5	.000
Likelihood Ratio	35.778	5	.000
Linear-by-Linear Association	1.610	1	.205
N of Valid Cases	313		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.90.

7.3.5 Effect of nationality on colour preference

In this section, nationality (Chinese and UK) is considered: 245 responses (179 Chinese

and 66 UK) were collected by the 6-alternative forced-choice method.

FIGURE 7.3.4 displays the colour preference distribution and correlation from Chinese and UK participants. The individual colour preference scores for Chinese were blue (25%), following by orange (20%), red (19%), yellow (16%), purple (11%) and green (10%); the colour preference score for UK were blue (27%), red (22%), purple (21%), orange (11%), yellow (9%) and green (9%). The two-descending order of individual colour preference from Chinese and UK (by 6-AFC) were: Blue > Red > Yellow > Orange > Purple > Green; and Blue > Red > Purple > Orange > Yellow = Green. the right image shows the correlation between the individual colour preferences from Chinese and participants. It is evident ($r^2=0.24$) that is some agreement between the data from the two methods.

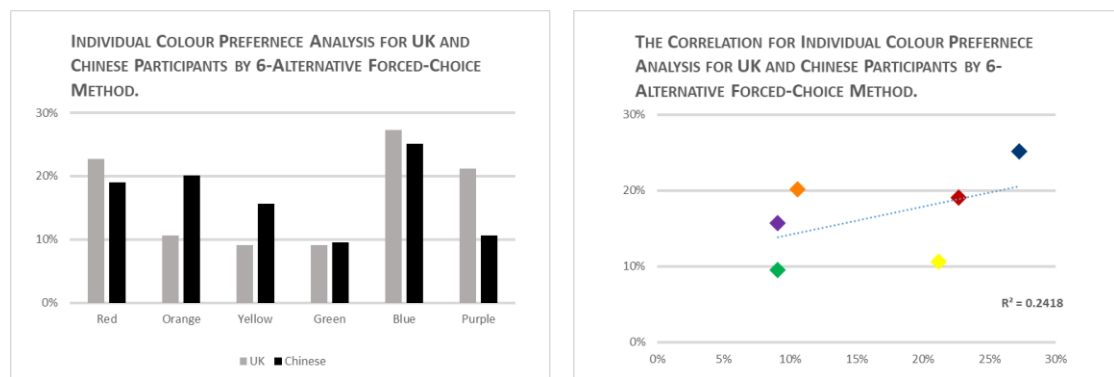


FIGURE 7.3.4 Individual colour preference distributions and the correlation for colour preference between UK and Chinese.

TABLE 7.3.3 Chi-Square Test of Independence result for individual colour preference between UK and Chinese.

Independent Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.405 ^a	5	0.135
Likelihood Ratio	8.427	5	0.134
Linear-by-Linear Association	2.086	1	0.149
N of Valid Cases	246		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.17.

Pairwise comparisons between Chinese and UK individual colour preference by the Chi-Squared Test for Independent were carried out, and it was found that there was no statistical significance between Chinese and UK ($p=0.135>0.05$) for individual colour preference (see TABLE 7.3.3) (RQ 4.3).

7.4 Effect of gender on consumer-purchase decisions

This section considers gender difference on product-colour consistency rates, gender difference on colour associations, gender difference on product-colour choosing reasons, gender difference on the connection between colour association and product-colour choosing reasons, and gender difference on product-colour decision time length.

7.4.1 Gender difference in product-colour consistency

In this section, for all of the experiments, participants were presented with six coloured products (red, orange, yellow, green, blue and purple) for each product, in turn, the order was presented randomly for each participant. TABLE 4.3 (Chapter 4), TABLE 5.3 (Chapter 5) and TABLE 6.3 (Chapter 6) show the products were selected. In addition, participants were asked to indicate which of these their preferred colour was by 6-alternative forced-choice method.

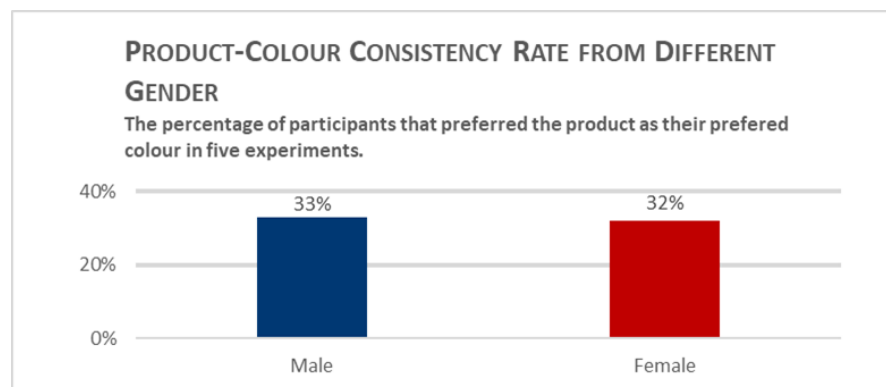


FIGURE 7.4.1 Product-colour consistency rate distributions from different genders.

313 responses were collected, comparison of 125 male and 188 female results. The

average *product-colour consistency rates* (the extent to which participants select a product in their preferred colour) for male and female were 33% and 32%. Both of them were greater than 17% suggesting that colour preference does affect participants' product-colour purchase decisions for both males and females (but that the extent of this varies between products). See FIGURE 7.4.1.

An Independent T-Test was conducted to compare the product-colour consistency for male and female conditions (See TABLE 7.4.1(a) and TABLE 7.4.1(b)). There was no significant difference ($p = 0.74 > 0.05$) in the scores for male ($M=0.33$, $SD=0.23$) and female ($M=0.32$, $SD=0.21$) participants (RQ 5.1).

TABLE 7.4.1(a) Group statistics result for product-colour consistency by gender.

Group Statistics					
	Gender	N	Mean	Std. Deviation	Std. Error Mean
Product_Consistency_Rates	Female	188	0.3208	0.21036	0.01534
	Male	125	0.3289	0.22874	0.01954

TABLE 7.4.1(b) Independent T-Test result in product-colour consistency by gender.

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	95% Confidence Interval of the Difference Upper
Product Consistency Rates	Equal variances assumed	2.602	0.108	-0.327	323	0.744	-0.0080	0.02452	-0.05626	0.04022
	Equal variances not assumed			-0.323	278.393	0.747	-0.0080	0.02485	-0.05693	0.04089

7.4.2 Product-colour purchase decision

The '*template approach*' analysis method (King, 2012) was recruited to code and organise data for classifying colour associations (the method was described in section 5.4.3). 37 responses were collected, 18 males and 19 females (all participants were

students or staff at the University of Leeds).

The ‘*template approach*’ analysis method (King, 2012) was recruited to code and organise data for classifying colour associations (the method was described in section 5.4.3). 37 responses were collected, 18 males and 19 females (all participants were students or staff at the University of Leeds).

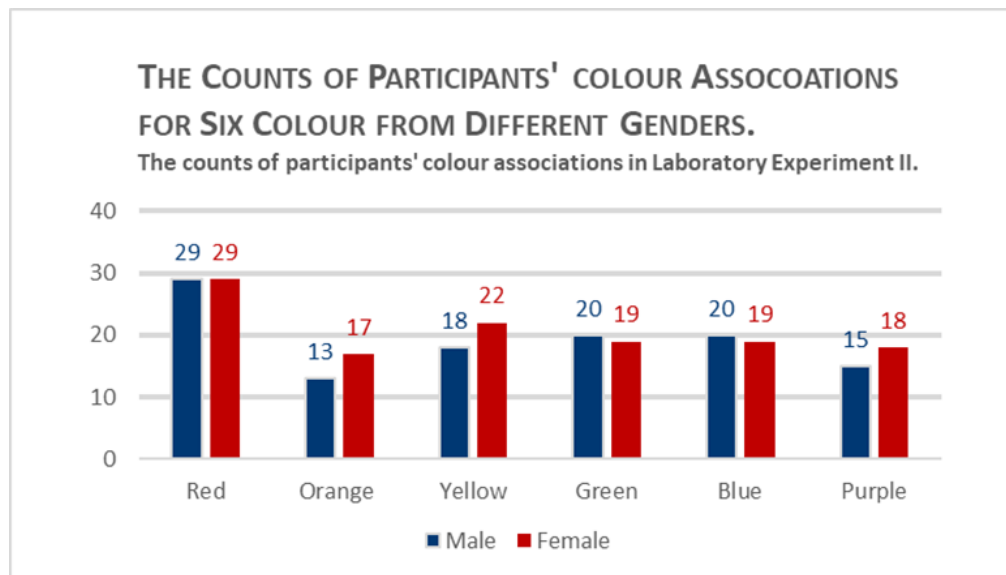


FIGURE 7.4.2 The counts of colour association for six colours from different genders.

FIGURE 7.4.2 shows the counts of colour associations that participants provided for each colour (red, orange, yellow, green, blue and purple). For male, 115 colour association key words were extracted from six colours; for female were 124 colour association key words. For male and female, there were 29 and 29 associations from red colour (such as ‘culture’ and ‘passion’); 13 and 17 from orange colour (such as ‘oranges’ and ‘warm’); 18 and 22 from yellow colour (such as ‘bright’ and ‘lemon’); 20 and 19 from green colour (such as ‘fresh’ and ‘grass’); 20 from blue colour (such as ‘sky’ and ‘comfortable’) and 15 and 18 from purple colour (such as ‘lavender’ and ‘elegant’). *Appendix F.1* and *Appendix F.2* provide the rank-ordered listing of colour association key words (including counts number and weighted percentages), which participants provided for each colour from males and females.

7.4.3 Gender difference in product-colour choosing reason

The ‘*template approach*’ analysis method (by NVivo) was also used to classify the product-colour choosing reasons (the method was described in section 5.4.4). 37 responses from 18 males and 19 females were collected.

FIGURE 7.4.3 shows the counts of product-colour decision reasons for 6 colours (red, orange, yellow, green, blue and purple) that participants provided for each product (51 product in this section, the product name list is in TABLE 5.3.1). For male, 174 product-colour decision reason key words were extracted from six colours; for female were 177 product-colour decision reason key words. For male and female, there were 53 and 40 reasons from red colour (such as ‘strawberry’ and ‘noticeable’); 33 and 38 from orange colour (such as ‘oranges’ and ‘warm’); 17 and 18 from yellow colour (such as ‘cheese’ and ‘milk’); 20 and 20 from green colour (such as ‘fresh’ and ‘bright’); 36 and 48 from blue colour (such as ‘cleanness’ and ‘masculine’) and 15 and 13 from purple colour (such as ‘lavender’ and ‘decoration’).

Appendix F.3 and *Appendix F.4* provide the rank-ordered listing of product-colour decision reason key words (including counts number and weighted percentages), which participants provided for each colour from males and females.

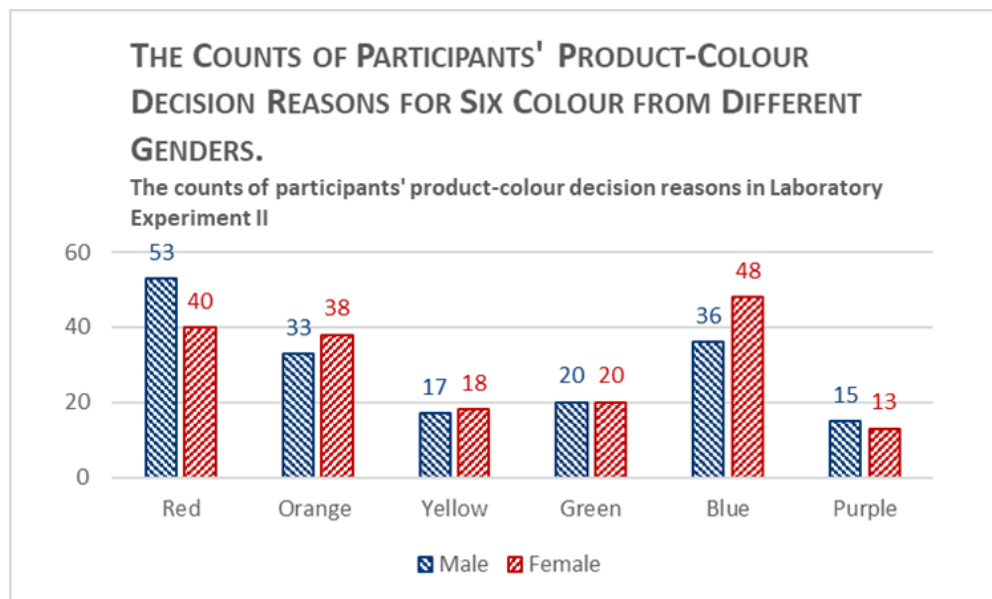


FIGURE 7.4.3 The counts of product-colour reason for six colours from different genders.

7.4.4 Gender difference in the connection between colour association and product-colour reason

For data analysis, the product-colour decision reason for each colour was compared with the colour-square associations. The extent to which the product-colour decision reason matches the colour-patch associations is calculated as a per cent figure (weight percentage) and this will be referred to as *the product-colour association score*.

The average product-colour association scores (six colours) from male and female were 30% and 50% (in other words, female have been stronger influenced by *colour association factor* than male for product-colour purchase decision). In this study, 18% (male) and 45% (female) red-product-colour decision reasons associated with red-colour square associations; 25% (male) and 60% (female) orange-product-colour decision reasons associated with orange-colour square associations; 8% (male) and 49% (female) yellow-product-colour decision reasons associated with yellow-colour square associations; 63% (male) and 48% (female) green-product-colour decision reasons associated with green-colour square associations; 59% (male) and 50% (female) blue-product-colour decision reasons associated with blue-colour square associations and 9% (male) and 50% (female) purple-product-colour decision reasons associated with purple-colour square associations between male and female (see the left image on FIGURE 7.4.4).

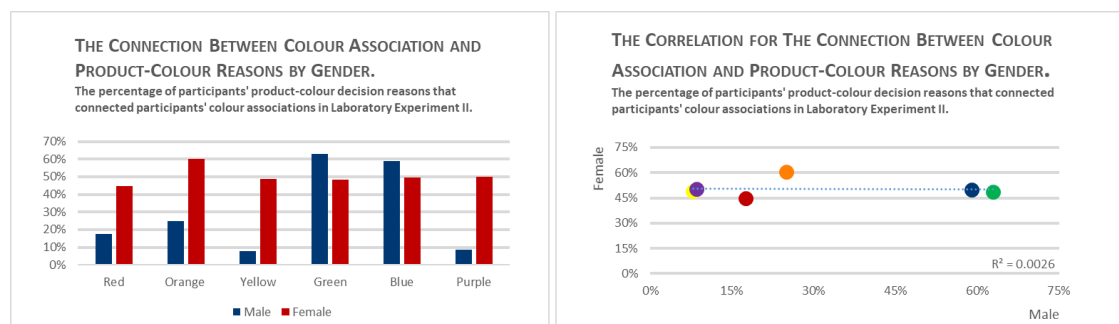


FIGURE 7.4.4 The connection between colour association and product-colour reason by gender.

The right image on FIGURE 7.4.4 shows the correlation of product-colour association scores between male and female (each filled coloured circle represents a colour). It is an evident ($r^2=0.003$) that there are few agreements between male and female for the connection between colour-patch associations and product-colour reasons (RQ 5.2).

7.4.5 Gender difference in the product-colour decision time length

The gender difference in product-colour decision time length consists of the counts of miss-response and product-colour decision time distributions by genders. Data from two research activities (Laboratory Experiment III and Laboratory Experiment IV) was used in this section which recorded the response-time for each question and each participant.

7.4.5.1 The counts of miss-response from different genders.

In Laboratory Experiment III (time-control experiment), the participants were asked to indicate the colour for each product within four seconds; otherwise, they were *miss-response* for this product/question. The experimental structures for Laboratory Experiment III were shown in FIGURE 6.3.2.1 and FIGURE 6.3.2.3 (Chapter 6). In the Laboratory Experiment III, the average counts of miss-response for male and female were 1.1 and 0.7. In other words, in the time-control (time-restrict) condition, female's product-colour decision time is shorter than male.

7.4.5.2 Product-colour decision time distributions from different genders.

In Laboratory Experiment IV (non-time-control experiment), the average product-colour decision-making time from male and female were 5.5 seconds and 6.1 seconds (see FIGURE 7.4.5.2). In other words, in the non-time-control condition, female's product-colour decision time is 0.6 second longer than male (RQ 5.3) within these 20 products (the product name list is shown in TABLE 6.3.1.2)

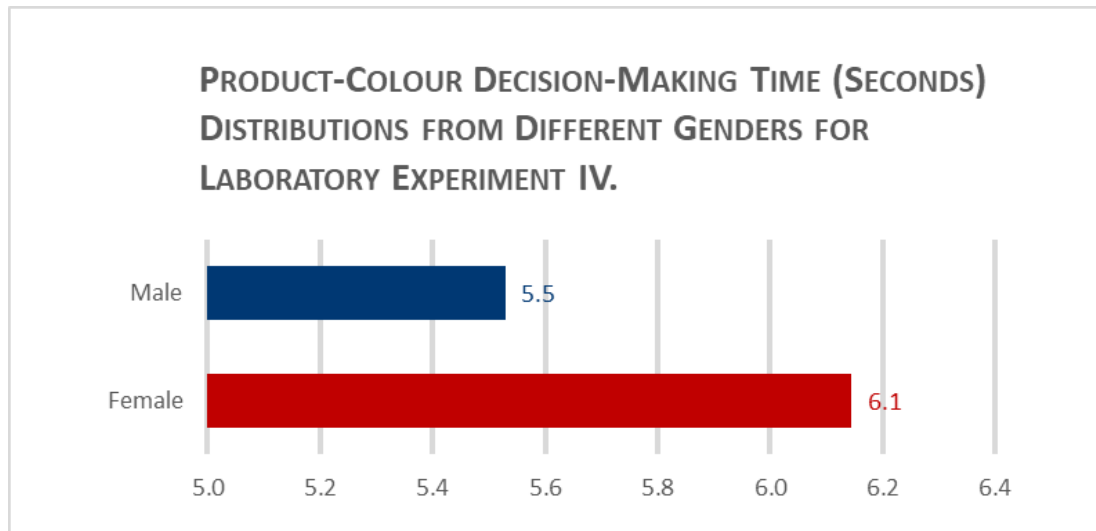


FIGURE 7.4.5.2 Product-colour decision time distributions from different genders for Laboratory Experiment IV.

7.4.5.3 The stability rate for product-colour decisions response from different genders.

The extent to which the chosen product-colour from Laboratory Experiment III matches the chosen product-colour from Laboratory Experiment IV is calculated as a per cent figure and this will be referred to as *the stability rate* for product-colour decisions response. This is done for each participant; that is, the per cent of products that are indicated that participant would buy the same colour both in time-control and non-time-control conditions.

Between Laboratory Experiment III and Laboratory Experiment IV, the average the stability rate for product-colour decisions response for male and female were 35% and 36%. In other words, both male and female may choose different product-colour in different time-length conditions.

7.5 Discussions and Conclusions

The main purposes of CHAPTER 7 were to test the effect of different research strategies (research methods and environments) and different participants groups (genders and

nationalities) on colour preferences; and to identify the difference that primary factors have on different gender groups. The present is a further analysis of data already described in Study I, II and III. This section concludes the key insights and critique of research methods for this study.

First of all, the individual colour preference results from this study gave two descending orders of individual colour preference from multiple choice for 6-alternative forced-choice and multiple choice for rank-order (Blue > Orange > Red > Purple > Yellow > Green). It shows that blue is the most strongly preferred colour regardless of the experimental method; whereas yellow and green are weakly preferred. The evidence shows an agreement between the two methods' result ($r^2=0.74$) (RQ 4.1).

A Monte Carlo analysis was used to explicitly test the effect of using fewer participants on the agreement between the two methods (6-AFC and Rank-Order). This was done by repeatedly sub-sampling over 1000 trials. The results from the Monte Carlo simulations show that the average correlation coefficients (r^2) variation range for 6-AFC method is wider than Rank-Order method. In other words, the Rank-Order method is more stable than the 6-AFC method. That suggests for studies involving small numbers of participants (participant factor), the rank-order method (experimental method factor) should be preferred (RQ 4). This is not a particularly surprising finding since intuitively the rank-order method is providing more information than the 6-AFC method. This also refers to CHAPTER 2, colour preference literature review.

Thirdly, this study also investigates whether individuals' colour preference was affected by gender or nationality. Pairwise comparisons for individual colour preference between genders (male and female) and nationalities (Chinese and UK) were carried out, and it was found that there was a statistical significance between male and female ($p=0.000<<0.05$, RQ 4.2) in individual colour preference (the two-descending order of colour preference from male and female (by 6-alternative forced-choice methods) were: Blue > Orange > Red = Green > Yellow > Purple; and Red > Purple = Blue > Yellow = Orange > Green; and there was no statistical significance between Chinese and UK

groups ($p=0.135>0.05$) in individual colour preference (RQ 4.3).

This chapter also explored the effect of gender on product-purchase response. For product-colour consistency, was no significant difference in the scores for male and female conditions ($p = 0.75>0.05$; RQ 5 and RQ 5.1). For colour-square associations, 115 and 124 colour association key words were extracted for six colours from male and female. Most of them (including keywords and weighted percentages) were similar (RQ 5.2).

However, for product colour decision reason, even 174 and 177 product-colour decision reason key words were extracted, but only 70 reasons appeared both on male and female. The average product-colour association scores (six colours) from male and female were 30% and 50%. It also provides an evident ($r^2=0.003$) that there are few agreements between male and female for the connection between colour-square associations and product-colour reasons. In other words, the product-colour decision reasons, which were connected to colour associations were higher for female than for males (RQ 5.2). Finally, in the time-control (time-restricted) condition, female's product-colour decision time was shorter than for males. Also, in the non-time-control condition, female's product-colour decision time length is 0.6 second longer than male. And both male and female may choose a different product-colour in different time-length conditions (RQ 5.3).

This work is limited and provides only a weak explanation for the correlation of product-colour decision stability rate and the increase of decision-making time. There is also a limited explanation for the correlation of the increase of decision-making time and the increase of product-colour consistency rate. The study notes that three studies were concerned with that aspect of colour known as hue. However, it is acknowledged that lightness and chroma may also be important for consumer purchase decisions. TABLE 7.5 lays out the limitations for this study, the improvements and the objectives for continual studies.

TABLE 7.5 Overview of limitations for CHAPTER 7, and the improvements and the objectives for further studies.

Limitations	Improvements	Objectives	Chapter
- Concerned with the aspects of colour as hue only.	- To add lightness and chroma into the colour aspects;	- To explore whether lightness and chroma may also be important for consumer purchase decisions.	Further Research (Chapter 8)
- A limited/week explanation for the correlation of product-colour decision stability rate and the increase of decision-making time; limited explanation for the correlation of the increase of decision-making time and increase of product-colour consistency rate.	- To expend large product categories and recruit more participant to attend the experiment.	-To further explain the relationship between product-colour decision stability rate and the increase of decision-making time, and the relationship between the increase of decision-making time and increase of product-colour consistence rate	Further Research (Chapter 8)

8 CHAPTER EIGHT – CONCLUSION AND DISCUSSION

‘In the research worker’s mind little did happen the way it is put down on paper, in terms of substance and sequence. What was ultimately assembled and ascertained, got caught in the familiar bouts of rationalizations that straighten out a zig-zag approach and turn the entire study into a well-organized logical design with a beginning and a rounded-off ending.’

-Hutheesing (1990)

8.1 Research review for this thesis

Reducing product overproduction (and hence reducing waste) would help to decrease environmental problems caused by manufacturing. One of the reasons that manufactured product cannot be sold is that the colour does not meet the expectation of the consumer. For designers and manufacturers, appropriate product colour selection schemes may generate desired results. This is one of the reasons that led to the overall research purpose for this thesis: To *explore* the effect of *product colour* on *consumer purchase behaviour*.

Three main research areas relate to the thesis: product-colour variety, colour theory and colour perception and preference. Product packaging, for example, has been suggested as a tool for product differentiation; additionally, product colours contain phenomenon and medium of visual perceptions and communications. Colour theory has been introduced as a scientific tool in product colour research and includes concepts such as colour standardisation, colour measurement and colour difference. Colour perception and preference, especially for colour preference and colour association, were reviewed to investigate the role of colour in consumers’ *product-colour preference* and *product-colour associations*. Four critical topics (see below) were identified and this led to five main research questions and twelve sub-research questions (TABLE 2.5, CHAPTER 2).

The main topics are:

1. To *explore* to what extent personal individual colour preference and personal colour association affects consumers' product-colour choice, and to explain why it happens;
2. To *explore* whether the length of shopping time affects consumers' product-colour choice and to predict what is likely to happen in different situations;
3. To *explore* and understand the relationships between colour preference, colour association, the length of shopping time and other factors when consumers purchase a colour of product;
4. To *evaluate* how much agreement are the results of individual colour preference from different research methods.

Previous research in these areas were reviewed and a research framework was designed for this thesis (FIGURE 3.3.3). An abductive approach was mainly chosen for this research, but this primary approach was combined with some deductive and inductive approaches. Three online surveys, one interview and four laboratory experiments were designed to collect both quantitative and qualitative data (FIGURE 3.3.3). Twelve research concepts were defined and nine data analysis methods were employed (TABLE 3.4.3). Additionally, the research objectives are given in TABLE 8.1.

TABLE 8.1 The research objectives and relevant chapters.

Research objectives	Chapter
To review the relevant literature and secondary sources in regards to the following: • The product packaging in consumer behaviour; • The key role of product-colour in product packaging; • The advantages of using colour information (individual colour preference and colour association) in product packaging; • The colour theory and colour information of individual colour preference and colour association;	2
To design a framework, research activities, research analysis methods and research definitions for the research;	3

To test whether personal general colour preference affects consumers' product-colour decision;	4
To find the relationship between colour preference and colour association when consumers purchase the colour of a product;	5
To evaluate whether the length of shopping (decision) time affects consumers' product-colour decision;	6
To compare the result agreement form different research methods for colour preference;	7
To find the result differentiation between gender and nationality group.	

8.2 Research contributions for this thesis

This thesis developed a framework to understand the relationship between consumers' product-colour purchase intentions and their colour perception and preference. It further explained how *colour factors* (primary factors and individual colour preference) work in relation to consumer product-colour purchase behaviour; additionally, explored that how the *factor influence elements* effect on colour factors. The overall framework shown in FIGURE 8.2.

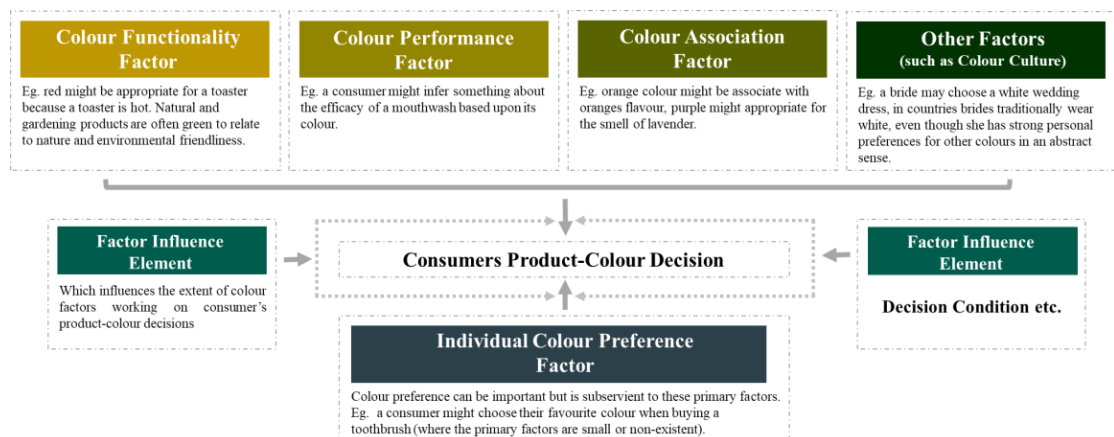


FIGURE 8.2 Framework for the whole thesis.

The experimental work was delivered in three studies and the aims and findings for these three studies are briefly summarised in the following text.

Study I tested whether consumers' individual colour preferences affect their intended

product purchase decisions given various colour choices. This was addressed using an online survey and a laboratory experiment which explicitly investigated which colour a participant would choose if asked to select a product to purchase when there is a range of colours available. The research was also designed to elicit a response about which colour each participant prefers in an abstract sense. The key findings of Study I are enumerated:

1. For 54 products tested, participants were more likely to indicate that they would purchase a product in their favourite colour than in a (different) random colour (RQ 1);
2. Individual colour preference influence factors and primary colour factors (colour functionality factor and colour preference factor) were introduced;
3. The first conceptual framework (FIGURE 4.2.2) suggests that consumer individual colour preferences are more likely to influence consumer product-purchase intentions in the absence of primary colour factors such as colour functionality and colour performance (RQ 1.1 and RQ 1.2).

Study II explored whether consumers' colour associations affected their intended product-colour purchase decisions. The work employed an interview and a laboratory experiment to investigate the relationship between colour association and product colour association in consumers' intended product colour decisions. The key findings are:

4. There were five groups (classifications) of colour square associations. There are Character, Objective, Emotional Associations, Psychological and Sensational associative (RQ 2.1);
5. For some of the products tested, participants were strongly influenced by the association for a particular colour and would very likely purchase a product in this colour rather than in any of the other colours (RQ 2.2 and RQ 2.3);

6. Consumers' individual colour preferences are more likely to influence consumer product-colour purchase intentions in the absence of primary colour factors such as colour association factor (RQ 2).

Study III evaluated the decision conditions, the length of shopping time in this research, and whether this affects the stability of consumers' product colour choices; additionally, does it influence the efficiency of colour factors on consumer' product-colour decision? The work employed two sets of online surveys and two laboratory experiments with short-time and long-time conditions. The key findings are:

7. Consumer may have more stable product-colour choices in a long-time decision-making (shopping) condition rather than in a short-time decision-making (shopping) condition (see FIGURE 6.4.2 (b)) (RQ 3.1);
8. Participants are more likely to purchase a product-colour the higher their general preference for that colour in both time conditions (long-time or short-time decision-making conditions) (RQ 3);
9. The extent of colour factors working on consumers' product-colour intention may vary between the different time conditions. Consumers may be influenced more by colour preference factor in the short-time shopping condition (the full framework is presented in FIGURE 6.2.2) (RQ 3.2).

Further analysis tested the agreement of the results of colour preference from two research methods (multiple choice for 6-alternative forced-choice and multiple choice for rank-order) and to identify the colour preference and product-colour result various between gender and nationality groups. Eight research activities with three research methods were employed for re-analysis (based on Study I, Study II and Study III). The key findings are:

10. Blue is the most strongly preferred colour regardless of the experimental method; whereas yellow and green are always weakly preferred. The evidence shows a

- general agreement between the 6-AFC and rank-order results ($r^2=0.74$) (RQ 4.1);
11. The rank-order method has a higher level of agreement between trials than the 6-AFC method for individual colour preference for studies involving small numbers of participants (RQ 4);
 12. There was a statistically significant difference between the results from male and female participants ($p=0.000<<0.05$, RQ 4.2); however, there was no significance difference between Chinese and UK groups ($p=0.135>0.05$) in individual colour preference results (RQ 4.3);
 13. For product-colour consistency there was no significant difference in the scores between males and females ($p = 0.75>0.05$; RQ 5 and RQ 5.1);
 14. Most colour-square associations were similar for males and females. However, product-colour decision reasons, which were connected to colour associations, were stronger for female than for males (RQ 5.2);
 15. Both males and females may choose a different product-colour in different time-length conditions (RQ 5.3).

The key conclusions regarding the research objectives are: Individual colour preferences do affect participants' product-colour purchase decisions but that the extent of this varies between products. Furthermore, consumers' individual colour preferences are more likely to influence their product-colour purchase intentions in the absence of primary colour factors such as colour functionality, colour performance, colour association factor etc. Additionally, the extent of colour factors working on consumers' product-colour intention may be various in different decision conditions such as time-length.

8.3 Conclusions and Discussions

This PhD research explored and investigated the effect of colour on consumer purchase behaviour. For this purpose, a number of studies of various product categories, level of

control (experiment environmental control, decision-time-length control) and influential scope were carried out. In previous research, colour has seldom been investigated in-context (Zhang *et al.*, 2019; Rathore *et al.*, 2020; Schloss *et al.*, 2020). However, in this research, the context (different product categories) plays a significant role in product colour research. Specifically, in this work a distinction has been made between consumers' colour perception and preference in terms of *abstract colour* (Feltman and Elliot, 2011; Farrelly *et al.*, 2013) and in terms of *product colour*. The relationship between these two is at the heart of the thesis.

Each of the studies had certain limitations and, although these were listed in the relevant chapters, it is important here to revisit the boundaries of the whole research and to address its overall limitations. Thus, the limitations worth considering are discussed below:

- 1) For the colour strategy of individual colour preference, this research only focuses on six hues (Red, Orange, Yellow, Green, Blue and Purple). Hue is explored categorically rather than as a continuous variable; however, this approach is consistent with a large number of papers in the literature (Ling *et al.*, 2006). In addition, hue was the only colour term that was considered; different saturation and brightness levels were not included. It is important that future work does explore saturation and brightness since difference in saturation (McManus *et al.* 1981; Ou *et al.* 2004; Palmer and Schloss 2010) and brightness (Guilford and Smith, 1959; McManus *et al.*, 1981) could certainly affect how human respond or behave.
- 2) In order to explore colour preference, this research employs the 6-alternative forced-choice and rank-order research methods. A Monte-Carlo simulation (sub-sampling) showed that the average correlation coefficients (r^2) variation range for a 6-AFC method is wider than for the Rank-Order method (the Rank-Order method has a high level of agreement with each trial than the 6-AFC method for individual colour preference). However, according to the literature (CHAPTER 2), there are

other methods that could also have been considered including N-alternative forced-choice (N-AFC, $N \geq 2$), paired-comparison, rank-order, affective judgments (or bipolar adjective), and subjective ratings. There is uncertainty in the level of agreement between these different research methods and further studies could explore this.

- 3) The weak finding for RQ 3.2 may be a consequence of a relatively small number of product categories and participants or the somewhat arbitrary selection of four seconds for the time control. However, the result from FIGURE 6.2.2 shows that the individual response time varies in the non-time control experiment. The use of a fixed time limit of four seconds in the time-control experiment may have been more or less problematic for different participants and probably some additional time controls should be considered in future research.
- 4) For the experimental materials, all the studies have been conducted on-screen (such as iPad, laptop, PC, smartphone etc.). In other words, no physical (reflective) objects were used in this study. In colour difference research there has been work to compare results obtained using physical samples and using samples displayed on an emissive screen. In the context of shopping, perhaps the results from this thesis may be more easily applied to 'Virtual Shopping' and further work would be needed to show that the same findings would apply for 'Physical Object Shopping' (or we say 'comparing consumers' perceptions and shopping orientation across physical and virtual-reality retail') (Pizzi *et al.*, 2019).
- 5) For the other influence elements (such as different scales of decision-making time), on the effect on individual colour preference factor and primary factors is uncertain.

To further understand the associations, without directly comparing estimated abstract colour associations to human judgments for product colour, it is unclear how well they match (Havasi *et al.*, 2010; Jahanian *et al.*, 2017). Further, questions remain about how

best to extract information from these databases to match human judgments. These estimates can serve as input for palette design, both for creating visualizations and for creating stimuli to use for visual reasoning studies on how people interpret visualizations.

On the other hand, brand colour design develops new packaging ideas that might contribute to brand recognition (Ward *et al.*, 2020). The environment may affect consumers' product-colour purchase intentions or behaviour (Kpossa and Lick, 2020). So far, colour research has focused on product or store environment, be it digital or physical (Bagchi and Cheema, 2012; Elliot and Maier, 2014; Kim *et al.*, 2020).

CHAPTER 2 introduced the observation that colour has three basic properties: hue, lightness and chroma (Faichild, 2013). Variation in any or all of these properties could influence downstream effects or behaviours; yet only hue is considered in this work (hue is also the main focus of theoretical ideas, Kumar, 2017). However, lightness (Kareklas *et al.*, 2014) and chroma (Lee *et al.*, 2013) also undoubtedly have implications for behaviour functioning (Kumar, 2017). Certainly, lightness and chroma are important and effect on products, designers, manufacturers, and retailers (Fornazarič and Toroš, 2018).

Another limitation of much research in this field is that research mainly focuses on individual colours, and fails to consider colour combinations or colour harmony (Jiang *et al.*, 2020; Luo *et al.*, 2019). In real life, colours occur in combination with other colours; colour combinations communicate with consumers visually and designers produce information visualizations by encoding concepts in visual features based on colour combinations and colour harmony (Brewer, 1994). It is not easy, however, to carry out research that explores the effect of colour combinations; in part this is because of the 'combinatorial explosion' that occurs because of the many combinations that inevitably exist. Nevertheless, it is evident that the majority of objects (certainly the majority of packaging) are multi-coloured (Li *et al.*, 2020).

The popularity of a product depends on colour and price (Li *et al.*, 2020). For different

products, designers need to understand consumer colour preferences and decide their order quantities accordingly to match their products to consumer demand. In this case, Sen (2008) suggested that companies are ‘far away from efficient use of sales data in their merchandise selections’. Some companies are starting to use consumer and sales data, however, to optimise their production. H&M, for example, is using big data and artificial intelligence to gain insights about fashion trends and their customers' preferences (Silva *et al.*, 2019). This perhaps suggests applications that in the future could optimise product colour using various methodologies to understand consumers' product colour demands or that can better forecast product colour sales. Ultimately a huge amount of retail data is available that is not being fully exploited.

Throughout this thesis the primary factors that drive consumer purchase decisions have often been presented as if they either exist or do not exist. In other words, as if colour has a functional relationship with the product or it doesn't. However, it is clear that the presence or absence of primary factors is not a binary choice. It is much more likely that there may be a degree to which colour is functional, for example. Figure 4.4.5, for example, demonstrates that for some product categories participants reported a high degree of functionality whereas a much lower degree of colour functionality was reported for some other product categories. Treating the primary factors as continuous variables rather than as either being present or absent has some interesting implications for predicting when (or to what extent) colour preference is likely to influence product-colour choices. For example, is there a threshold for the primary factors, below which colour preference becomes important? This is a question that should be addressed in future research.

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Appendix A

TABLE A.1 Definitions of the 13 types of colour information (Won, 2018).

The 13 types of colour information	
Colour in art and design	Colour applications are well-known in design works and paintings (Osborne, 2012).
Colour harmony	Colours in neighbouring areas which arouse a pleasing effect (Judd, 1952).
Colour history	The background and development for a particular colour (Błaszczuk, 2012).
Colour and light	The wavelength and frequencies which human are sensitive (Westland <i>et al.</i> , 2007).
Colour meaning	Certain colours are associated with meanings (Osborne, 2012).
Colour measurement	The act for quantifying or measuring colour by colour measurement instruments (Zwinkels, 1996).
Colour notation	The logical and visual ways to describe or communicate colours (Zelanski and Fisher, 1999).
Colour perception	How colours draw humans' attention (Imram, 1999) or how human react to colours (Webster, 1996; Zeki, 2002).
Colour preference	Colour preference is concerned with which colours individuals prefer among alternatives (Mikellides, 2012; Ou <i>et al.</i> , 2003).
Colour printing	The colour quality or print techniques of colour printing (Parraman, 2012).
Colour psychology	Human mind and behaviour linked to specific colours (Oxford English Dictionary, 2015; O'Connor, 2009).

Colour theory	The systematic frameworks and rules to explain or understand colour both in scientifically and psychologically (Feiser, 2006).
Colour trend	The colour of products or material is on-trend popular (Oxford English Dictionary, 2015; Hedefi, 2017).

Appendix B

B.1 Selection of product namelist table for Study II (Chapter 5)

Table B.1 The CIELAB colour coordinates for 10 of the products in each of the six basic colours in order to demonstrate the extent of the variability (the ΔE is the average colour difference between the product colours and the colour squares Table 4.3).

Colour variability																		
Coloured-objects	Red			Orange			Yellow			Green			Blue			Purple		
	L^*	 a^*	b^*	L^*	 a^*	b^*	L^*	 a^*	b^*	L^*	 a^*	b^*	L^*	 a^*	b^*	L^*	 a^*	b^*
Yogurt	56.03	72.50	65.38	67.74	39.01	81.44	94.41	-18.58	99.19	85.72	-87.36	87.39	31.95	111.85	-127.49	44.02	90.95	-91.55
Washing Up Liquid	58.56	72.25	71.50	68.94	41.49	77.94	94.61	-20.65	97.67	86.18	-86.50	83.68	30.01	88.23	-109.61	45.57	77.05	-80.33
Soap Bar	56.49	71.03	69.96	69.47	39.97	78.60	97.28	-9.53	103.90	90.56	-81.79	91.80	30.34	89.45	-108.69	43.08	80.01	-88.48
Shave Splash	56.17	68.61	72.02	63.02	42.40	77.85	96.53	-14.26	99.66	87.09	-85.49	90.06	29.20	111.45	-126.04	41.61	71.80	-76.95
Milk	57.03	70.30	74.86	67.77	40.65	82.38	97.33	-15.67	102.48	87.76	-78.81	88.58	32.06	97.41	-119.30	43.15	82.97	-86.06
Ice Cream	56.49	71.25	72.13	68.84	37.41	72.15	95.77	-14.35	90.92	87.53	-80.40	84.79	28.37	111.53	-125.77	46.44	85.99	-85.92
Hand Cream	56.58	69.00	72.43	66.46	45.62	79.01	94.41	-8.62	101.21	87.53	-82.34	89.07	33.17	84.51	-105.48	42.18	76.87	-82.51
Cream	57.96	64.29	73.78	69.24	35.60	80.73	94.61	-15.64	99.56	87.31	-84.49	89.08	28.49	98.61	-116.89	44.94	86.97	-78.49
Candy	55.57	69.37	70.20	69.92	37.26	76.11	93.03	-10.49	99.13	87.09	-82.19	89.06	28.37	81.90	-102.98	41.46	81.22	-81.55
Calculator	57.16	68.86	66.88	68.21	36.45	72.49	93.82	-12.08	89.12	87.09	-80.94	86.86	27.50	82.76	-102.18	45.00	87.20	-81.41
ΔE	5.90			7.01			11.92			6.36			14.24			7.01		

Table B.1 The coloured images for two of the products in each of the six colour options and the six colour squares that were used to determine colour preference.

Colour Variability										
Coloured-objects	Yogurt	Washing Up Liquid	Soap Bar	Shave Splash	Milk	Ice Cream	Hand Cream	Cream	Candy	Calculator
Red										
Orange										
Yellow										
Green										
Blue										
Purple										

B.2 Selection of product namelist table for Study III (Chapter 6)

Table B.2.1 The CIELAB colour coordinates for 20 products in each of the six basic colours in order to demonstrate the extent of the variability (the ΔE is the average colour difference between the product colours and the colour squares in Table 4.3).

Colour variability																		
Coloured-objects	Red			Orange			Yellow			Green			Blue			Purple		
	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*
Calculator	57.16	68.86	66.88	68.21	36.45	72.49	93.82	-12.08	89.12	87.09	-80.94	86.86	27.50	82.76	-102.18	45.00	87.20	-81.41
Candy	55.57	69.37	70.20	69.92	37.26	76.11	93.03	-10.49	99.13	87.09	-82.19	89.06	28.37	81.90	-102.98	41.46	81.22	-81.55
Cheese	56.72	70.88	72.48	70.41	37.03	78.03	98.20	-14.39	105.33	88.20	-83.04	94.21	25.80	75.39	-97.22	43.49	93.86	-93.49
Cream	57.96	64.29	73.78	69.24	35.60	80.73	94.61	-15.64	99.56	87.31	-84.49	89.08	28.49	98.61	-116.89	44.94	86.97	-78.49
Dental Floss	58.18	72.53	76.34	69.40	28.38	88.05	95.69	-11.81	128.32	87.31	-84.55	85.47	27.38	106.95	-116.67	43.82	74.25	-77.27
Deodorant	56.26	72.73	77.00	70.34	37.60	77.91	93.23	-21.13	102.94	89.07	-78.34	88.29	28.97	90.98	-109.91	40.43	74.86	-72.87
Hand Cream	56.58	69.00	72.43	66.46	45.62	79.01	94.41	-8.62	101.21	87.53	-82.34	89.07	33.17	84.51	-105.48	42.18	76.87	-82.51
Hand Wash	56.76	71.11	71.40	68.38	35.48	80.47	95.00	-6.62	114.47	89.29	-82.88	89.22	28.13	108.79	-118.86	42.80	90.14	-80.24
Ice Cream	56.49	71.25	72.12	68.84	37.41	72.15	95.77	-14.35	90.92	87.53	-80.40	84.97	28.37	11.53	-125.77	46.44	85.99	-85.92
Laundry Detergent	54.63	68.47	70.99	69.34	39.91	78.58	95.00	-16.35	100.11	87.53	-78.00	87.42	28.25	104.87	-123.86	40.06	80.28	-77.51
Make Up Remover	55.19	68.65	72.17	67.94	34.73	80.11	95.77	-14.85	115.26	86.86	-77.14	91.10	26.87	115.71	-120.54	42.01	75.42	-77.84
Milk	57.30	70.30	74.68	67.77	40.65	82.38	97.33	-15.67	102.48	87.76	-78.81	88.58	32.06	97.41	-119.30	43.15	82.97	-86.06
Shave Splash	56.17	68.61	72.02	63.02	42.40	77.85	96.53	-14.26	99.66	87.09	-85.49	90.06	29.20	11.45	-126.04	41.61	71.80	-76.95
Soap Bar	56.49	71.03	69.96	69.47	39.97	78.60	97.28	-9.53	103.90	90.56	-81.97	91.80	30.34	89.45	-108.69	43.08	80.01	-88.48
Table Cleaner	56.94	69.98	76.45	70.37	35.40	82.97	95.77	-14.77	102.13	85.26	-76.24	88.27	28.97	109.49	-123.29	41.32	92.03	-93.22
Toner	51.94	65.66	66.23	65.53	37.47	76.05	95.77	-13.43	102.01	85.26	-84.51	87.59	34.04	114.99	-135.58	42.74	80.70	-79.91
Toothpaste	55.62	67.78	65.06	68.07	26.54	87.37	96.53	-20.54	94.04	85.26	-83.74	87.18	29.55	99.54	-115.91	42.87	75.40	-85.84
Vase	55.34	68.44	74.77	69.80	44.14	85.94	96.72	-12.94	98.88	85.95	-84.19	83.76	27.50	96.43	-114.29	41.82	74.18	-81.43
Washing Up Liquid	58.56	72.25	71.50	68.94	41.49	77.94	94.61	-20.65	97.67	86.18	-86.50	83.68	30.01	88.23	-109.61	45.57	77.05	-80.33
Yogurt	56.03	72.50	65.38	67.74	39.01	81.04	94.41	-18.58	99.19	85.72	-87.36	87.39	31.95	111.85	-127.49	44.02	90.95	-91.55
ΔE	6.49			6.69			11.96			7.27			13.68			7.97		

Table B.2.2 The coloured images for 20 products in each of the six colour options and the six colour squares that were used to determine colour preference.

Colour Variability																				
Coloured-objects	Calculator	Candy	Cheese	Cream	Dental Floss	Deodorant	Hand Cream	Hand Wash	Ice Cream	Laundry Detergent	Makeup Remover	Milk	Shave Splash	Soap Bar	Table Cleaner	Toner	Toothpaste	Vase	Washing Up Liquid	Yogurt
Red																				
Orange																				
Yellow																				
Green																				
Blue																				
Purple																				

Appendix C

C.1 Online Survey (Study I).

The survey of consumers purchasing behaviour of the colour tendency

This survey consists of three parts: the general information of participant, the colour tendency of purchasing behaviour, and colour preference. It has 60 question, might cost you 10-15 minutes.

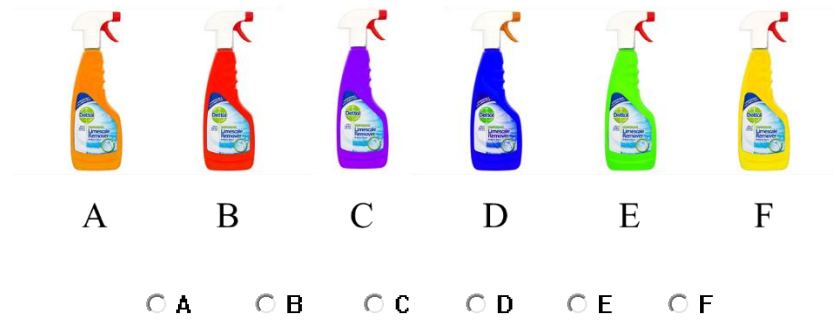
*Required

General information for participants

1. Your gender *
2. Your age *
3. Your nationality *

Skip to question 4

4. Which Table Cleaner would you choose to buy? *



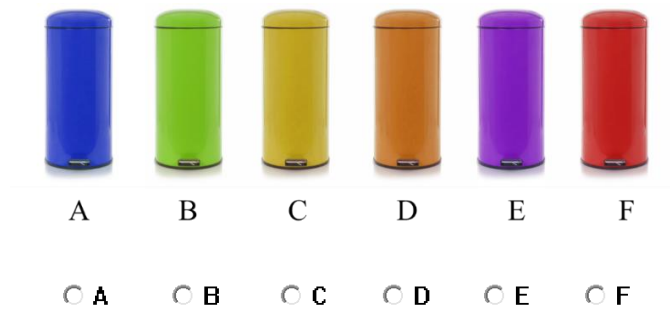
5. Which Shower Gel would you choose to buy? *



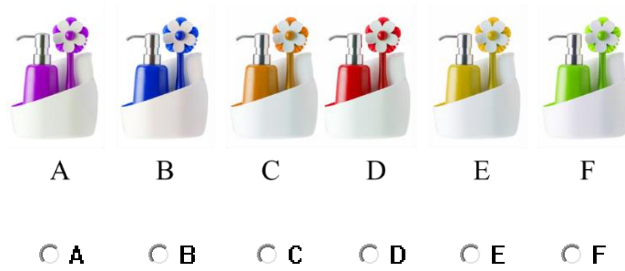
6. Which Condom would you choose to buy? *



7. Which Bin would you choose to buy? *



8. Which Bathroom Set would you choose to buy? *



9. Which Coffee Maker would you choose to buy? *



10. Which Facial Cream would you choose to buy? *



11. Which Hand Wash Gel would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

12. Which Washing Up Liquid would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

13. Which Toilet Gel would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

14. Which Dental Floss would you choose to buy?

*



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

15. Which Deodorant would you choose to buy?



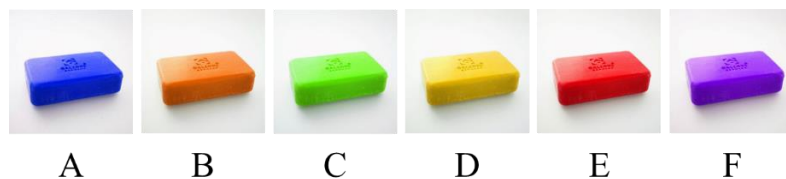
☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

16. Which Mouthwash would you choose to buy?



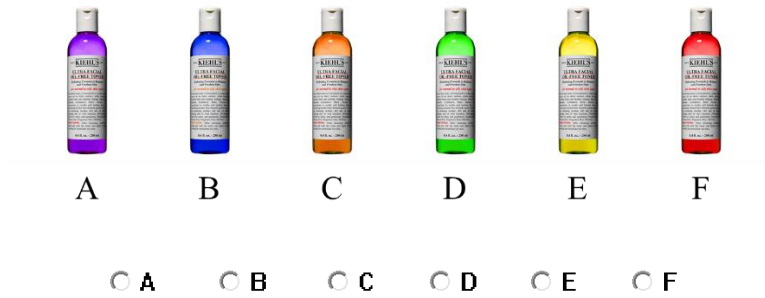
☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

17. Which Soap Bar would you choose to buy? *



☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

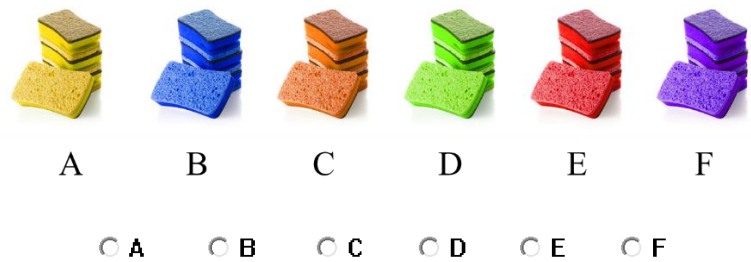
18. Which Toner would you choose to buy? *



19. Which Hand Cream would you choose to buy? *



20. Which Cleaning Sponge would you choose to buy? *



21. Which Laundry Detergent would you choose to buy? *



☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

22. Which Shampoo would you choose to buy? *



A



B



C



D



E



F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

23. Which Iron would you choose to buy? *



A



B



C



D



E



F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

24. Which Toilet Tissue would you choose to buy?

*



A



B



C



D



E



F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

25. Which Tissue would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

26. Which Bulb would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

27. Which Face Brush would you choose to buy?

*



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

28. Which Toothpaste would you choose to buy?

*



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

29. Which Espresso Maker would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

30. Which Iron Casserole Pot would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

31. Which Cleaner would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

32. Which Facial Cleaner would you choose to buy? *



A

B

C

D

E

F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

33. Which Hair Dryer would you choose to buy?

*



A

B

C

D

E

F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

34. Which Shave Splash would you choose to buy? *



A

B

C

D

E

F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

35. Which Towels would you choose to buy? *



A

B

C

D

E

F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

36. Which Opener would you choose to buy? *



A



B



C



D



E



F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

37. Which Tableware would you choose to buy?

*



A



B



C



D



E



F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

38. Which Makeup-Remover would you choose to buy? *



A



B



C



D



E



F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

39. Which Hair Treatment would you choose to buy? *



A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

40. Which Bowl Set would you choose to buy? *



A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

41. Which Kettle would you choose to buy? *



A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

42. Which Pan would you choose to buy? *



A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

43. Which Scissors would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

44. Which Slice Toaster would you choose to buy?

*



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

45. Which Stew Pot would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

46. Which Tooth Brush would you choose to buy?

*



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

47. Which Chair would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

48. Which Sanitary Towel would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

49. Which Dustpan would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

50. Which Candle would you choose to buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

51. Which Picnic Box would you choose to buy?

*



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

52. Which Bottle Opener would you choose to

buy? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

53. Which Hair Brush would you choose to buy?

*



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

54. Which Water Maker would you choose to

buy? *



A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

55. Which Steam Cleaner would you choose to buy? *



A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

56. Which Mug would you choose to buy? *



A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

57. Which Gift Set would you choose to buy? *

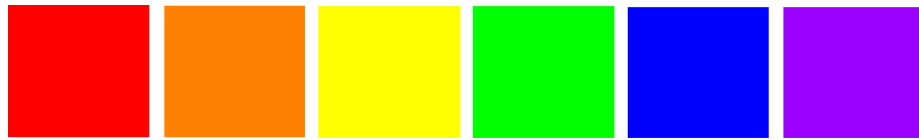


A B C D E F

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

Individual Colour Preference Test

58. Which colour square do you prefer most? *



A

B

C

D

E

F

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

C.2 Information Sheet Form (Study I).

Information Sheet

Research title: The role of colour preference on consumers' purchasing behaviour

'You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.'

What is the purpose of the project?

The aims are following: 1) to explore whether consumers' product-colour decisions are affected by colour preference and other factors; 2) to explain why colour preference seems to matter for some product categories but not for others; 3) to identify the relationships between colour preference and other factors (these factors are described in the next section) when consumers purchase a product of a particular colour.

Why have I been chosen?

Anyone age above 18 with a normal colour vision can take part in this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form and you can still withdraw at any time without it affecting any benefits that you are entitled to in any way. You do not have to give a reason.

What do I have to do?

The experiment will carry out to ascertain the colour that you would prefer to buy for each product. Additionally, you will ask to indicate, for each product, the extent to which you think colour could be related to performance or function. At the end of the experiment, you will ask to indicate which colour (from the six coloured squares) you prefer most.

Other things you might like to know.

The participant will be given a copy of the information sheet. For further information please contact Luwen Yu on ml14l2y@leeds.ac.uk. Thank you for taking the time to read through the information.

C.3 Information Consent Form (Study I).

Consent to take part in [The role of colour preference on consumers' purchasing behaviour]

Add your initials
next to the
statement if you
agree

• I confirm that I have read and understand the information sheet dated [insert date] explaining the above research project.	
• I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question(s), I am free to decline.	
• I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report(s) that result from the research.	
• I agree for the data collected from me to be stored and used in relevant future research in an anonymised form.	
• I understand that other genuine researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.	
• I understand that other genuine researchers may use my words in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.	
• I understand that relevant sections of the data collected during the study, may be looked at by individuals from the University of Leeds or from	

regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.	
I agree to take part in the above research project and will inform the lead researcher should my contact details change.	

Name of participant:

Name of researcher: Luwen Yu

Researcher's signature:

Participant's signature:

Yu Luwen .

Date:

Date: / /

2016

C.4 PVAC & Arts joint Faculty Research Ethics Committee

University of Leeds

Performance, Governance and Operations

Research & Innovation Service

Charles Thackrah Building

101 Clarendon Road

Leeds LS2 9LJ Tel: 0113 343 4873

Email: ResearchEthics@leeds.ac.uk



UNIVERSITY OF LEEDS

Luwen Yu
School of Design
University of Leeds
Leeds, LS2 9JT

PVAC & Arts joint Faculty Research Ethics Committee University of Leeds

Dear Luwen Yu

Title of study **Consumers' purchasing behaviour of the colour tendency**
Ethics reference **LTDESN-045**

I am pleased to inform you that the above application for light touch ethical review has been reviewed by a School Ethics Representative of the PVAC and Arts (PVAR) joint Faculty Research Ethics Committee. I can confirm a favourable ethical opinion on the basis of the application form as of the date of this letter. The following documentation was considered:

Document	Version	Date
LTDESN-045 Consumers purchasing behavior of the colour tendency.docx	1	31/03/16

Please notify the committee if you intend to make any amendments to the original research as submitted at date of this approval as all changes must receive ethical approval prior to implementation. The amendment form is available at <http://ris.leeds.ac.uk/EthicsAmendment>.

Please note: You are expected to keep a record of all your approved

documentation, as well as documents such as sample consent forms, and other documents relating to the study. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at <http://ris.leeds.ac.uk/EthicsAudits>.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

Jennifer Blaikie
Senior Research Ethics Administrator, Research & Innovation Service
On behalf of Dr Kevin Macnish, Chair, [PVAR FREC](#)

CC: Student's supervisor

Appendix D

D.1 Experimental samples procedure for Study II (51 products, the table is five pages long).

Product name	Red	Orange	Yellow	Green	Blue	Purple
Alarm Clock						
Back Cushion						
Bag						
Bike						
Calculator						
Candy						
Cheese						
Chocolate						

Coffee Maker						
Condoms						
Cream						
Dental Floss						
Deodorant						
Floor Lamp						
Gloves						
Hand Cream						
Hand Wash Gel						
Hat						
Headphone						
Ice Cream						

Laptop						
Laundry Detergent						
Lighter						
Makeup-Remover						
Milk						
Mouse						
Notebook						
Pan						
Pants						
Pen						
Photo Frame						
PlayStation						
Shave Splash						

Shoe						
Shower Gel						
Smart Phone						
Soap Bar						
Sock						
Sofa						
Suitcase						
Table Cleaner						
Tie						
Toner						
Tool Kit						
Toothpaste						
Trousers						

T-Shirt						
USB						
Vase						
Washing Up Liquid						
Yogurt						

D.2 Information Sheet Form (Study II).

Information Sheet

Research title: The role of colour association on consumers' purchasing behaviour.

'You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.'

What is the purpose of the project?

The aims are following: 1) to analyse the classifications of colour-square associations that consumers will provide when they see the colour squares; 2) to lay out the reasons why consumers purchase a particular colour of product; 3) to test whether colour association influences consumers' product-colour decisions; 4) to identify the relationship between colour preference factor and colour association factor (primary factor) when consumers purchase a product of a particular colour.

Why have I been chosen?

Anyone age above 18 with a normal colour vision can take part in this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form and you can still withdraw at any time without it affecting any benefits that you are entitled to in any way. You do not have to give a reason.

What do I have to do?

Two research activities (an interview and a laboratory experiment) will carry out in a laboratory to ascertain the colour that you would prefer to buy for each product. In the interview, you will additionally ask to indicate, for each product, why you choose this colour. At the end of this study, you will ask to give an order for your colour preference for six colour, also to provide the colour associations for each colour squares.

Other things you might like to know.

The participant will be given a copy of the information sheet. For further information please contact Luwen Yu on ml1412y@leeds.ac.uk. Thank you for taking the time to read through the information.

D.3 Information Consent Form (Study II).

Consent to take part in [The role of colour association on consumers' purchasing behaviour]

Add your initials
next to the
statement if you
agree

• I confirm that I have read and understand the information sheet dated [insert date] explaining the above research project.	
• I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question(s), I am free to decline.	
• I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report(s) that result from the research.	
• I agree for the data collected from me to be stored and used in relevant future research in an anonymised form.	
• I understand that other genuine researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.	
• I understand that other genuine researchers may use my words in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.	
• I understand that relevant sections of the data collected during the study, may be looked at by individuals from the University of Leeds or from	

regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.	
I agree to take part in the above research project and will inform the lead researcher should my contact details change.	

Name of participant:

Name of researcher: Luwen Yu

Researcher's signature:

Participant's signature:

Yu Luwen .

Date:

Date: / /

2016

D.4 Frequencies of key words from colour square association

(Study II, the table is two pages long).

Colour Name	Word (Association)	Count	Weighted (%)	Word (Association)	Count	Weighted (%)
Red	Culture	19	17.12	Festival	1	0.90
	Passion	10	9.01	Football	1	0.90
	China	7	6.31	Ripe Fruit	1	0.90
	National Flag	7	6.31	Happy	1	0.90
	Fire	5	4.50	Hot-Pot	1	0.90
	Warm	5	4.50	Lipstick	1	0.90
	Blood	4	3.60	Luck	1	0.90
	Strawberry	4	3.60	Marriage	1	0.90
	Bright	4	3.60	Meat	1	0.90
	New Year	3	2.70	Medical	1	0.90
	Cheerful	2	1.80	Mood	1	0.90
	Energy	2	1.80	Positive	1	0.90
	Excitement	2	1.80	Profile	1	0.90
	Sun	2	1.80	Publicity	1	0.90
	Abrupt	1	0.90	Rose	1	0.90
	Africa	1	0.90	Signal	1	0.90
	Alarm	1	0.90	Sports	1	0.90
	Attract	1	0.90	Staff	1	0.90
	Barbecue	1	0.90	Summer	1	0.90
	Brave	1	0.90	Tomato	1	0.90
	Cherry	1	0.90	Vibrant	1	0.90
	Cranberry	1	0.90	Watermelon	1	0.90
	Evil	1	0.90	Motivation	1	0.90
	Exercise	1	0.90	Vivo	1	0.90
Orange	Oranges	18	30.51	Fruit	1	1.69
	Warm	8	13.56	Hermes	1	1.69
	Comfortable	4	6.78	Hot	1	1.69
	Sun	4	6.78	Leather	1	1.69
	Moderate	2	3.39	Lined	1	1.69
	Skin	2	3.39	Nature	1	1.69
	Bright	1	1.69	Peaches	1	1.69
	Clam	1	1.69	Soft	1	1.69
	Camel	1	1.69	Vibrant	1	1.69
	Cortex	1	1.69	Vitality	1	1.69
	Disgusting	1	1.69	Wood	1	1.69
	Eating	1	1.69	Young	1	1.69
	Eyeful	1	1.69	Vivo	1	1.69
	Fireman	1	1.69			
Yellow	Lemon	11	15.71	Food	1	1.43
	Bright	7	10.00	Gold	1	1.43
	Sun	5	7.14	Iconic	1	1.43
	Banana	4	5.71	Lively	1	1.43
	Warm	4	5.71	Morning	1	1.43
	Fresh	3	4.29	Negative	1	1.43
	Light	3	4.29	Passionate	1	1.43
	Catching Eyes	2	2.86	Pure	1	1.43
	Cool	2	2.86	Sour	1	1.43

	Happy	2	2.86	Sunflower	1	1.43
	High-Profile	2	2.86	Uncomfortable	1	1.43
	Warning	2	1.43	Vibrant	1	1.43
	Active	1	1.43	Wheat	1	1.43
	Butter	1	1.43	Egg Yolk	1	1.43
	Candle	1	1.43	Attractive	1	1.43
	Cheese	1	1.43	Attention	1	1.43
	Elegant	1	1.43	Vivo	1	1.43
	Fluorescent	1	1.43			
Green	Fresh	8	12.90	Clam	1	1.61
	Grass	7	12.90	Comfortable	1	1.61
	Nature	6	11.29	Coquettish	1	1.61
	Plants	5	9.68	Dazzling	1	1.61
	Cool	3	4.84	Directly	1	1.61
	Leaves	3	4.84	Fluorescent	1	1.61
	Bright	3	4.84	Mint	1	1.61
	Trees	3	4.84	Practical	1	1.61
	Environmental Friendly	2	3.23	Quite	1	1.61
	Forest	2	3.23	Ready	1	1.61
	Positive	2	3.23	Spring	1	1.61
	Protection	2	3.23	Sunshine	1	1.61
	Vegetables	2	3.23	Traffic	1	1.61
Blue	Calm	11	13.92	Fashion	1	1.27
	Fresh	11	13.92	Lake	1	1.27
	Sky	11	13.92	Lofty	1	1.27
	Sea	9	11.39	Melancholy	1	1.27
	Comfortable	4	5.06	Minded	1	1.27
	Cool	3	3.80	Nature	1	1.27
	Low-Profile	3	3.80	Office	1	1.27
	Water	3	3.80	Original	1	1.27
	Man	3	3.80	Public	1	1.27
	Deep	2	2.53	Space	1	1.27
	Rational	2	2.53	Sportswear	1	1.27
	Broad	1	1.27	Trust	1	1.27
	Efficient	1	1.27	Vast	1	1.27
	Expensive	1	1.27	Cleanness	1	1.27
Purple	Lavender	8	16.33	Dream	1	2.04
	Luxury	4	8.16	Friendless	1	2.04
	Elegant	3	6.12	Happy	1	2.04
	Grapes	3	6.12	Magic	1	2.04
	Mysterious	3	6.12	Night	1	2.04
	Gentle	2	4.08	Peaceful	1	2.04
	High-Profile	2	4.08	Plant	1	2.04
	Sky	2	4.08	Positive	1	2.04
	Feminine	2	4.08	Psychedelic	1	2.04
	Aristocracy	1	2.04	Romantic	1	2.04
	Blueberry	1	2.04	Sensitive	1	2.04
	Carpet	1	2.04	Sex	1	2.04
	Comfortable	1	2.04	Sleeping	1	2.04
	Coquettish	1	2.04	Violet	1	2.04
	Decoration	1	2.04			

D.5 Frequencies of key words from product-colour purchase decision reasons (the table is nine pages long).

Product Name	Colour Name	Word (Association)	Count	Weighted (%)	Word (Association)	Count	Weighted (%)
Alarm Colck	Colour Preference		11	23.91			
	Red	<u>Alarm</u>	<u>3</u>	<u>6.52</u>	<u>Cheerful</u>	<u>1</u>	<u>2.17</u>
		Refresh	3	6.52	Colour Combination	1	2.17
		Tense	3	6.52	Decoration	1	2.17
		Noticeable	2	4.35	Morning	1	2.17
		<u>Bright</u>	<u>1</u>	<u>2.17</u>	<u>Passion</u>	<u>1</u>	<u>2.17</u>
	Orange	Active	1	2.17	<u>Warm</u>	<u>1</u>	<u>2.17</u>
		Cute	1	2.17			
	Yellow	<u>Bright</u>	<u>1</u>	<u>2.17</u>	<u>Refresh</u>	<u>1</u>	<u>2.17</u>
		<u>Morning</u>	<u>1</u>	<u>2.17</u>	<u>Sun</u>	<u>1</u>	<u>2.17</u>
	Green	<u>Fresh</u>	<u>1</u>	<u>2.17</u>			
	Blue	<u>Clam</u>	<u>2</u>	<u>4.35</u>	Cool-Down	2	4.35
	Purple	Colour Combination	2	4.35	Clam	1	2.17
		Decoration	2	4.35	<u>Cool-Down</u>	<u>1</u>	<u>2.17</u>
Back Cushion	Colour Preference		14	34.15			
	Red	Colour Combination	2	4.88	Decoration	1	2.44
		Comfortable	1	2.44	<u>Warm</u>	<u>1</u>	<u>2.44</u>
	Orange	Warm	6	14.63	Colour Combination	3	7.32
		Against Dirty	5	12.20	<u>Comfortable</u>	<u>1</u>	<u>2.44</u>
	Blue	Sunshine	1	2.44			
	Purple	Comfortable	2	4.88	Colour Combination	1	2.44
		Warm	2	4.88	Decoration	1	2.44
Bag	Colour preference		18	46.15			
	Red	<u>Bright</u>	<u>1</u>	<u>2.56</u>	Lovely	1	2.56
		Durable	1	2.56	Noticeable	1	2.56
		Energetic	1	2.56	Vital	1	2.56
	Orange	Against Dirty	2	5.13	Colour Combination	1	2.56
		<u>Bright</u>	<u>1</u>	<u>2.56</u>			
	Yellow	Adventure	1	2.56	<u>Lovely</u>	<u>1</u>	<u>2.56</u>
		Comfortable	1	2.56	<u>Noticeable</u>	<u>1</u>	<u>2.56</u>
		Cute	1	2.56	Sport	1	2.56
		Energetic	1	2.56			
	Blue	Against Dirty	1	2.56	<u>Low Profile</u>	<u>1</u>	<u>2.56</u>
		Colour Combination	1	2.56	<u>Masculine</u>	<u>1</u>	<u>2.56</u>
Bike	Colour preference		13	30.23			
	Red	<u>Bright</u>	<u>3</u>	<u>6.98</u>	<u>Alarm</u>	<u>1</u>	<u>2.33</u>
		Noticeable	3	6.98	<u>Attractive</u>	<u>1</u>	<u>2.33</u>
		Safe	2	4.65	<u>Passion</u>	<u>1</u>	<u>2.33</u>
		Active	1	2.33	Personalized	1	2.33
	Yellow	<u>Bright</u>	<u>2</u>	<u>4.65</u>	<u>Noticeable</u>	<u>1</u>	<u>2.33</u>

		Cute	1	2.33	Safe	1	2.33
		Durable	1	2.33	Strong	1	2.33
	Green	Bright	2	4.65	Safe	2	4.65
		Noticeable	2	4.65	Grass	1	2.33
	Blue	Against dirty	1	2.33	Noticeable	1	2.33
		Bovish	1	2.33			
Calculator	Colour preference		13	38.24			
	Familiar		1	2.94			
	Red	Colour Contrast	2	5.88	Rigorous	1	2.94
		Preciseness	1	2.94			
	Blue	Calm	3	8.82	Official	1	2.94
		Colour Contrast	2	5.88	Ordinary	1	2.94
		Academic	1	2.94	Science	1	2.94
		Business	1	2.94	Stable	1	2.94
		Comfortable	1	2.94	Steady	1	2.94
		Noticeable	1	2.94	Technology	1	2.94
	Purple	Decoration	1	2.94			
Candy	Familiar		1	2.50			
	Red	Strawberry	8	20.00	Watermelon	1	2.50
		Fruits	1	2.50			
	Orange	Oranges	10	25.00	Health	1	2.50
	Yellow	Lemon	6	15.00	Banana	1	2.50
		Health	3	7.50	Mango	1	2.50
		Nature	3	7.50			
	Green	Apple	1	2.50			
	Purple	Grape	1	2.50	Not Nature	1	2.50
		Interesting	1	2.50			
Cheese	Colour preference		3	8.11			
	Familiar		2	5.41			
	Yellow	Cheese	26	70.27	Dairy	3	8.11
	Green	Fresh	2	5.41	Vegetable	1	2.70
Chocolate	Colour preference		2	7.69			
	Familiar		2	7.69			
	Red	Dark	3	11.54	High quality	1	3.85
		Chocolate	2	7.69	Warm	1	3.85
		Strawberry	2	7.69	High quality	1	3.85
	Orange	Chocolate	2	7.69	Fruit	1	3.85
		Orange	4	15.38	Warm	1	3.85
	Yellow	Banana	1	3.85	Sweet	1	3.85
	Green	Mint	1	3.85			
	Blue	Original	1	3.85			
	Purple	High Quality	1	3.85			
Coffee Maker	Colour preference		13	34.21			
	Red	Bright	1	2.63	Kitchen	1	2.63
		Coffee Bean	7	18.42	Professional	1	2.63
		Warm	2	5.26	Refresh	1	2.63
		Decoration	1	2.63	Stimulate	1	2.63
		Hot Drink	1	2.63			
	Orange	Coffee Bean	5	13.16	Warm	2	5.26
	Blue	Cool Down	1	2.63			
	Purple	Decoration	1	2.63			
Condoms	Colour preference		4	12.90			
	Familiar		4	12.90			
	Red	Energetic	1	3.23	Exciting	1	3.23

		Passion	<u>5</u>	<u>16.13</u>	Reliable	1	3.23
		Enjoy	1	3.23	Sexy	1	3.23
		Excitatory	1	3.23			
	Orange	Orange	1	3.23			
	Yellow	Low Profile	1	3.23	Rich	1	3.23
	Green	Fresh	<u>1</u>	<u>3.23</u>			
	Blue	Safety	4	12.90	Warm	1	3.23
	Purple	Attractive	1	3.23	Romantic	<u>1</u>	<u>3.23</u>
		Fantasy	1	3.23			
Cream	Colour preference		3	7.89			
	Familiar		1	2.63			
	Red	Skim	1	2.63			
	Yellow	Food	9	23.68	Cream	4	10.53
		Milk	6	15.79	Nature	4	10.53
		Health	5	13.16	Fresh	1	2.63
	Green	Farm	1	2.63	Fresh	<u>1</u>	<u>2.63</u>
	Blue	Double	1	2.63			
	Purple	Birthday	1	2.63			
Dental Floss	Colour preference		5	13.16			
	Familiar		5	13.16			
	Green	Cleanness	1	2.63	Mint	<u>1</u>	<u>2.63</u>
	Blue	Cleanness	<u>11</u>	<u>28.95</u>	Hygiene	1	2.63
		Tooth	3	7.89	Medical	1	2.63
		Fresh	<u>2</u>	<u>5.26</u>	Mint	1	2.63
		Health	2	5.26	Nature	<u>1</u>	<u>2.63</u>
		Hospital	1	2.63	Reliable	1	2.63
	Purple	Comfortable	<u>1</u>	<u>2.63</u>	Distinctive	1	2.63
Deodorant	Colour preference		3	8.57			
	Familiar		1	2.86			
	Red	Strawberry	<u>2</u>	<u>5.71</u>			
	Yellow	Cool	<u>2</u>	<u>5.71</u>	Lemon	<u>2</u>	<u>5.71</u>
	Green	Cool	<u>1</u>	<u>2.86</u>			
	Blue	Cool	<u>6</u>	<u>17.14</u>	Cleanness	<u>3</u>	<u>8.57</u>
		Fresh	<u>6</u>	<u>17.14</u>	Personal care	2	5.71
	Purple	Lavender	<u>7</u>	<u>20.00</u>			
Floor Lamp	Colour preference		17	38.64			
	Familiar		1	2.27			
	Red	Warm	<u>2</u>	<u>4.55</u>	Decoration	1	2.27
		Colour Combination	1	2.27	Light	1	2.27
	Orange	Decoration	2	4.55	Warm	<u>1</u>	<u>2.27</u>
		Light	2	4.55			
	Yellow	Colour Combination	2	4.55	Warm	<u>2</u>	<u>4.55</u>
		Decoration	2	4.55	Sofy	1	2.27
		Light	<u>2</u>	<u>4.55</u>			
	Blue	Cleanness	<u>1</u>	<u>2.27</u>	Colour Combination	1	2.27
		Decoration	2	4.55	Comfortable	<u>1</u>	<u>2.27</u>
	Purple	Decoration	1	2.27	Elegance	<u>1</u>	<u>2.27</u>
Gloves	Colour preference		13	29.55			
	Red	Warm	<u>4</u>	<u>9.09</u>	Colour Combination	1	2.27
		Bright	<u>1</u>	<u>2.27</u>			
	Orange	Warm	<u>3</u>	<u>6.82</u>	Noticeable	1	2.27

	Yellow	Colour Combination	1	2.27	<u>Noticeable</u>	<u>1</u>	<u>2.27</u>
		<u>Light</u>	<u>1</u>	<u>2.27</u>	Younger	1	2.27
		Nature	1	2.27			
	Green	Alam	1	2.27	Light	1	2.27
		<u>Bright</u>	<u>1</u>	<u>2.27</u>	Shine	1	2.27
		Fun	1	2.27			
	Blue	Against Dirty	2	4.55	Dark	1	2.27
		Colour Combination	2	4.55	<u>Low Profile</u>	<u>1</u>	<u>2.27</u>
	Purple	Against Dirty	1	2.27	<u>Sexy</u>	<u>1</u>	<u>2.27</u>
		<u>Elegant</u>	<u>1</u>	<u>2.27</u>	Warm	1	2.27
		<u>Peaceful</u>	<u>1</u>	<u>2.27</u>			
Hand Cream		Colour preference	4	11.11			
		Familiar	2	5.56			
	Red	<u>Raspberry</u>	<u>2</u>	<u>5.56</u>	Pomegranate	1	2.78
		<u>Strawberry</u>	<u>2</u>	<u>5.56</u>	<u>Warm</u>	<u>1</u>	<u>2.78</u>
		<u>Cranberry</u>	<u>1</u>	<u>2.78</u>			
	Orange	<u>Orange</u>	<u>3</u>	<u>8.33</u>	Cheerful	1	2.78
		<u>Warm</u>	<u>2</u>	<u>5.56</u>	<u>Distinctive</u>	<u>1</u>	<u>2.78</u>
	Yellow	<u>Lemon</u>	<u>5</u>	<u>13.89</u>	Nutrition	1	2.78
		<u>Warm</u>	<u>3</u>	<u>8.33</u>	Skin	1	2.78
		<u>Fresh</u>	<u>1</u>	<u>2.78</u>			
	Green	<u>Fresh</u>	<u>1</u>	<u>2.78</u>	<u>Nature</u>	<u>1</u>	<u>2.78</u>
	Blue	Hygiene	1	2.78			
Hand Wash	Purple	<u>Lavender</u>	<u>2</u>	<u>5.56</u>			
		Colour preference	5	12.20			
		Familiar	2	4.88			
	Red	Anti-Bacteria	1	2.44	<u>Strawberry</u>	<u>1</u>	<u>2.44</u>
		Determine	1	2.44			
	Orange	Papaya	1	2.44	Lemon	1	2.44
	Yellow	Clearness	1	2.44			
	Green	Apple	4	9.76	Clean	2	4.88
		<u>Fresh</u>	<u>2</u>	<u>4.88</u>	<u>Cool</u>	<u>1</u>	<u>2.44</u>
	Blue	<u>Cleanness</u>	<u>14</u>	<u>34.15</u>	<u>Cool</u>	<u>1</u>	<u>2.44</u>
		<u>Water</u>	<u>2</u>	<u>4.88</u>	<u>Fresh</u>	<u>1</u>	<u>2.44</u>
	Purple	<u>Lavender</u>	<u>1</u>	<u>2.44</u>			
Hat		Colour preference	12	36.36			
	Red	<u>Warm</u>	<u>3</u>	<u>9.09</u>	Colour Combination	1	3.03
		<u>Bright</u>	<u>1</u>	<u>3.03</u>	Noticeable	1	3.03
	Orange	<u>Bright</u>	<u>4</u>	<u>12.12</u>	Low Profile	1	3.03
		Distinctive	1	3.03			
	Yellow	<u>Warm</u>	<u>1</u>	<u>3.03</u>	Colour Combination	1	3.03
	Blue	Against Dirty	2	6.06	Sporty	1	3.03
		Colour Combination	2	6.06	Winter	1	3.03
		Dark	1	3.03			
Headphone		Colour preference	25	62.50			
		Familiar	1	2.50			
	Red	Noticeable	3	7.50	High Quality	1	2.50
		<u>Bright</u>	<u>1</u>	<u>2.50</u>	Loudness	1	2.50
		Decoration	1	2.50			
		Enjoy	1	2.50			
	Yellow	Music	1	2.50			

	Green	Bright	<u>1</u>	<u>2.50</u>	Noticeable	1	2.50
		Energetic	1	2.50			
	Blue	Against Dirty	1	2.50			
Ice Cream	Familiar		1	2.78			
	Red	Strawberry	<u>4</u>	<u>11.11</u>	Watermelon	<u>1</u>	<u>2.78</u>
		Chocolate	1	2.78			
	Orange	Orange	<u>3</u>	<u>8.33</u>			
	Yellow	Lemon	<u>8</u>	<u>22.22</u>	Fresh	<u>1</u>	<u>2.78</u>
		Vanilla	5	13.89	Happiness	1	2.78
		Milk	3	8.33	Health	1	2.78
		Banana	<u>1</u>	<u>2.78</u>	Pineapple	1	2.78
		Cool	1	2.78	Tasty	1	2.78
		Delicious	1	2.78			
	Green	Tea	1	2.78			
	Purple	Blueberry	<u>1</u>	<u>2.78</u>			
Laptop	Colour preference		18	54.55			
	Red	Distinctive	1	3.03	Noticeable	1	3.03
		Motivate	1	3.03			
	Orange	Against dirty	1	3.03	High quality	1	3.03
		Comfortable	1	3.03	Light	1	3.03
		Energetic	1	3.03	Noticeable	1	3.03
	Yellow	Attractive	1	3.03	Fresh	1	3.03
	Blue	Low Profile	<u>2</u>	<u>6.06</u>	Against Dirty	1	3.03
	Purple	Special	1	3.03			
Launder Detergent	Colour preference		4	10.53			
	Familiar		7	18.42			
	Red	Cranberry	<u>1</u>	<u>2.63</u>			
	Orange	Cleanness	1	2.63	Soft	<u>1</u>	<u>2.63</u>
	Yellow	Cleanness	1	2.63			
	Green	Cleanness	1	2.63	Fresh	<u>1</u>	<u>2.63</u>
		Eco-Friendly	<u>1</u>	<u>2.63</u>			
	Blue	Cleanness	<u>10</u>	<u>26.32</u>	Medicine	1	2.63
		Strong	2	5.26	Personal-Care	1	2.63
		Eco-Friendly	1	2.63	Refreshing	<u>1</u>	<u>2.63</u>
	Purple	Lavender	<u>2</u>	<u>5.26</u>	Flower	1	2.63
		Distinguish	1	2.63			
Lighter	Colour preference		14	38.89	Alarm	1	2.78
	Red	Fire	<u>10</u>	<u>27.78</u>	Alarm	<u>1</u>	<u>2.78</u>
	Orange	Fire	1	2.78	High Quality	1	2.78
	Yellow	Warm	2	5.56	Fire	1	2.78
		Noticeable	1	2.78	Petrol	1	2.78
	Blue	Safety	2	5.56	Masculine	<u>1</u>	<u>2.78</u>
		Cool Down	<u>1</u>	<u>2.78</u>			
Make Up Remover	Colour preference		4	9.52			
	Familiar		5	11.90			
	Orange	Skin	<u>1</u>	<u>2.38</u>			
	Yellow	Champagne	1	2.38	Elegance	1	2.38
		Cleanness	1	2.38			
	Green	Cleanness	3	7.14	Natural	<u>2</u>	<u>4.76</u>
		Cool	<u>2</u>	<u>4.76</u>	Tea	1	2.38
		Fresh	<u>2</u>	<u>4.76</u>			
	Blue	Cleanness	<u>11</u>	<u>26.19</u>	Cool	<u>1</u>	<u>2.38</u>
		Fresh	<u>2</u>	<u>4.76</u>	Mint	1	2.38
		Water	<u>2</u>	<u>4.76</u>	Natural	<u>1</u>	<u>2.38</u>
	Purple	Elegance	<u>1</u>	<u>2.38</u>			

Milk	Colour preference		5	14.71			
	Familiar		1	2.94			
	Red	Semantic-Colour	1	2.94			
	Orange	<u>Orange</u>	<u>1</u>	<u>2.94</u>			
	Yellow	<u>Banana</u>	<u>4</u>	<u>11.76</u>	<u>Warm</u>	<u>2</u>	<u>5.88</u>
		Health	4	11.76	<u>Egg</u>	<u>1</u>	<u>2.94</u>
		Milk	4	11.76	<u>Fresh</u>	<u>1</u>	<u>2.94</u>
		Less-Artifical	2	5.88			
	Green	<u>Fresh</u>	<u>3</u>	<u>8.82</u>	Semantic-Colour	1	2.94
		<u>Nature</u>	<u>1</u>	<u>2.94</u>			
Blue	Fruit	1	2.94	Semantic-Colour	1	2.94	
Purple	<u>Grape</u>	<u>1</u>	<u>2.94</u>				
Mouse	Colour preference		15	41.67			
	Familiar		1	2.78			
	Red	Noticeable	1	2.78	Technology	1	2.78
		<u>Passion</u>	<u>1</u>	<u>2.78</u>			
	Orange	<u>Bright</u>	<u>2</u>	<u>5.56</u>	Safety	1	2.78
		Noticeable	1	2.78	Special	1	2.78
	Yellow	<u>Noticeable</u>	<u>1</u>	<u>2.78</u>	Special	1	2.78
	Green	<u>Bright</u>	<u>2</u>	<u>5.56</u>	Safety	1	2.78
		Noticeable	1	2.78	Special	1	2.78
	Blue	Against dirty	3	8.33	Work	1	2.78
Peaceful		1	2.78				
Notebook	Colour preference		17	48.57			
	Familiar		1	2.86			
	Red	Noticeable	3	8.57	<u>Motivation</u>	<u>1</u>	<u>2.86</u>
	Orange	<u>Leather</u>	<u>1</u>	<u>2.86</u>	Noticeable	1	2.86
	Yellow	<u>Noticeable</u>	<u>1</u>	<u>2.86</u>	Realistic	1	2.86
	Green	Noticeable	1	2.86			
	Blue	Nerious	2	5.71	Business	1	2.86
		Academic	1	2.86	<u>Low Profile</u>	<u>1</u>	<u>2.86</u>
		Against dirty	1	2.86	<u>Official</u>	<u>1</u>	<u>2.86</u>
	Purple	Noticeable	1	2.86			
Pan	Colour preference		9	21.43			
	Familiar		6	14.29			
	Red	<u>Fire</u>	<u>8</u>	<u>19.05</u>	<u>Warm</u>	<u>2</u>	<u>4.76</u>
		Heat	5	11.90	Chili	1	2.38
		Hot	4	9.52	Tasty	1	2.38
		Colour Combination	2	4.76			
	Orange	Against Dirty	1	2.38			
	Yellow	Cleanness	1	2.38			
	Green	Safety	1	2.38			
	Purple	Decoration	1	2.38			
Pants	Colour preference		10	32.26			
	Red	<u>Luck</u>	<u>6</u>	<u>19.35</u>	Sexy	1	3.23
	Orange	<u>Soft</u>	<u>1</u>	<u>3.23</u>			
	Yellow	Clean	1	3.23			
	Blue	Dark	3	9.68	<u>Cool</u>	<u>1</u>	<u>3.23</u>
		Colou Combination	2	6.45	<u>Low Profile</u>	<u>1</u>	<u>3.23</u>
		Against Dirty	1	3.23	<u>Masculine</u>	<u>1</u>	<u>3.23</u>
		<u>Clean</u>	<u>1</u>	<u>3.23</u>	Soft	1	3.23
Purple	<u>Romantic</u>	<u>1</u>	<u>3.23</u>				
Pen	Colour preference		20	50.00			

	Familiar	2	5.00			
	Red	Bright	2	5.00	Clam	1 2.50
		Noticeable	2	5.00		
	Orange	Bright	1	2.50	Noticeable	1 2.50
		High Quality	1	2.50		
	Yellow	Colour Combaiaon	1	2.50		
	Green	Noticeable	1	2.50		
	Blue	Ink	5	12.50	Serious	1 2.50
		Peaceful	1	2.50		
	Purple	Elegance	1	2.50		
Photo Frame	Colour preference	16	32.00			
	Red	Warm	4	8.00	Colour Harmony	2 4.00
		Sweet	3	6.00	China	1 2.00
		Decoration	2	4.00	Home	1 2.00
	Orange	Sweet	3	6.00	Colour Harmony	2 4.00
		Warm	3	6.00	Highlight	2 4.00
	Yellow	Highlight	2	4.00	Sweet	1 2.00
	Blue	Highlight	3	6.00	Dark	1 2.00
	Purple	Attractive	1	2.00	Sweet	1 2.00
		Decoration	1	2.00	Warm	1 2.00
PlayStation	Colour preference	20	57.14			
	Familiar	1	2.86			
	Red	Passion	2	5.71	High Quality	1 2.86
		Exciting	1	2.86		
	Orange	Fun	1	2.86	Passion	1 2.86
		Passion	1	2.86	Unusual	1 2.86
	Yellow	Playful	1	2.86		
		Concentrate	1	2.86	Safe	1 2.86
	Blue	Dark	1	2.86	Serious	1 2.86
		Relax	1	2.86		
Shave Splash	Colour preference	1	2.04			
	Familiar	2	4.08			
	Green	Cool	1	2.04	Fresh	1 2.04
		Energetic	1	2.04		
	Blue	Cleanness	11	22.45	Mint	2 4.08
		Cool	9	18.37	Effective	1 2.04
		Fresh	9	18.37	Moisturizing	1 2.04
		Masculine	6	12.24	Nature	1 2.04
		Hygiene	2	4.08	Swimming	1 2.04
Shoe	Colour preference	19	63.33			
	Familiar	1	3.33			
	Red	Colour Combination	3	10.00	Noticeable	1 3.33
	Yellow	Bright	1	3.33		
	Blue	Against Dirty	3	10.00	Colour Combination	1 3.33
	Purple	Against Dirty	1	3.33		
Shower Gel	Colour preference	5	12.20			
	Familiar	1	2.44			
	Red	Exciting	1	2.44		
	Orange	Orange	2	4.88	Papaya	1 2.44
		Cool	3	7.32	Honey	1 2.44
	Yellow	Fresh	2	4.88	Less-Artificial	1 2.44
		Lemon	2	4.88	Pineapple	1 2.44
	Green	Cleanness	1	2.44	Fresh	1 2.44

	Blue	<u>Cool</u>	<u>4</u>	<u>9.76</u>	<u>Cleanness</u>	<u>2</u>	<u>4.88</u>
		<u>Fresh</u>	<u>3</u>	<u>7.32</u>	Hygiene	1	2.44
		<u>Mint</u>	<u>3</u>	<u>7.32</u>	<u>Masculine</u>	<u>1</u>	<u>2.44</u>
	Purple	<u>Lavender</u>	<u>2</u>	<u>4.88</u>	Interesting	1	2.44
		Fancy	1	2.44	<u>Romantic</u>	<u>1</u>	<u>2.44</u>
Smart Phone	Colour preference		23	56.10			
	Red	<u>Attractive</u>	<u>3</u>	<u>7.32</u>	Noticeable	2	4.88
		<u>Brave</u>	<u>3</u>	<u>7.32</u>	<u>Motivate</u>	<u>1</u>	<u>2.44</u>
		Distinctive	2	4.88			
	Orange	Feminine	1	2.44	Passion	1	2.44
	Yellow	<u>Bright</u>	<u>1</u>	<u>2.44</u>	<u>Distinctive</u>	<u>1</u>	<u>2.44</u>
	Blue	<u>Low profile</u>	<u>2</u>	<u>4.88</u>			
	Purple	<u>Elegance</u>	<u>1</u>	<u>2.44</u>			
Soap Bar	Colour preference		4	11.76			
	Familiar		4	11.76			
	Red	Degerming	1	2.94			
	Orange	<u>Nature</u>	<u>1</u>	<u>2.94</u>	<u>Skin</u>	<u>1</u>	<u>2.94</u>
		<u>Orange</u>	<u>1</u>	<u>2.94</u>	<u>Warm</u>	<u>1</u>	<u>2.94</u>
		<u>Peach</u>	<u>1</u>	<u>2.94</u>			
	Yellow	Cleanness	2	5.88	<u>Fresh</u>	<u>1</u>	<u>2.94</u>
		Health	2	5.88	Nature	1	2.94
		<u>Lemon</u>	<u>2</u>	<u>5.88</u>	Soap	1	2.94
		Less Artificial Colour	2	5.88			
	Green	Cleanness	2	5.88	Fresh	1	2.94
		<u>Eco-Friendly</u>	<u>1</u>	<u>2.94</u>			
	Blue	<u>Cleanness</u>	<u>1</u>	<u>2.94</u>	Mint	1	2.94
		<u>Cool</u>	<u>1</u>	<u>2.94</u>			
	Purple	<u>Lavender</u>	<u>1</u>	<u>2.94</u>	Unusual	1	2.94
Sock	Colour preference		13	33.33			
	Familiar		1	2.56			
	Red	<u>Luck</u>	<u>4</u>	<u>10.26</u>	Christmas	2	5.13
		<u>Happy (Cheerful)</u>	<u>3</u>	<u>7.69</u>	<u>Chinese</u>	<u>1</u>	<u>2.56</u>
		<u>Warm</u>	<u>3</u>	<u>7.69</u>	<u>New Year</u>	<u>1</u>	<u>2.56</u>
	Orange	<u>Warm</u>	<u>2</u>	<u>5.13</u>			
	Yellow	Clean	1	2.56	<u>Warm</u>	<u>1</u>	<u>2.56</u>
		Colour Combination	1	2.56			
	Blue	Against-Dirty	4	10.26	Dark	1	2.56
		Colour Combination	1	2.56			
Sofa	Colour preference		14	37.84			
	Familiar		1	2.70			
	Red	<u>Warm</u>	<u>2</u>	<u>5.41</u>	Decoration	1	2.70
		Colour Combination	1	2.70			
	Orange	<u>Comfortable</u>	<u>2</u>	<u>5.41</u>	Relaxing	1	2.70
		<u>Leather</u>	<u>2</u>	<u>5.41</u>	<u>Soft</u>	<u>1</u>	<u>2.70</u>
		Brown	1	2.70	<u>Warm</u>	<u>1</u>	<u>2.70</u>
	Yellow	Comfortable	2	5.41	Decoration	1	2.70
		Beige	1	2.70	High Quality	1	2.70
		Colour Combination	1	2.70	Warm	1	2.70
	Blue	Against Dirty	1	2.70			
	Purple	Decoration	1	2.70	<u>Peaceful</u>	<u>1</u>	<u>2.70</u>

Suitcase	Colour preference		21	52.50		
	Familiar		2	5.00		
	Red	Noticeable	3	7.50	High Quality	1 2.50
		<u>Attractive</u>	<u>1</u>	<u>2.50</u>		
	Orange	<u>Bright</u>	<u>2</u>	<u>5.00</u>	<u>Comfortable</u>	<u>1</u> <u>2.50</u>
		Against Dirty	1	2.50		
	Yellow	<u>Noticeable</u>	<u>2</u>	<u>5.00</u>	<u>Bright</u>	<u>1</u> <u>2.50</u>
	Green	Against Dirty	2	5.00		
Table Cleaner	Blue	Noticeable	1	2.50	<u>Sky</u>	<u>1</u> <u>2.50</u>
		<u>Masculine</u>	<u>1</u>	<u>2.50</u>		
	Colour preference		4	10.53		
	Familiar		8	21.05		
	Orange	Anti-bacteria	1	2.63	Cleanness	1 2.63
	Yellow	Cleanness	3	7.89	<u>Lemon</u>	<u>2</u> <u>5.26</u>
	Green	Cleanness	4	10.53	<u>Eco-Friendly</u>	<u>1</u> <u>2.63</u>
		Disctinctive	1	2.63	Hygiene	1 2.63
Tie	Blue	<u>Cleanness</u>	<u>8</u>	<u>21.05</u>	Less Artificial Colour	1 2.63
		Health	1	2.63		
	Purple	<u>Lavender</u>	<u>2</u>	<u>5.26</u>		
	Colour preference		9	27.27		
	Familiar		1	3.03		
	Red	Clam	1	3.03	Power	1 3.03
		Colour Combination	1	3.03	Sober	1 3.03
		Formal	1	3.03		
Toner	Orange	Unusual	1	3.03		
	Green	Attractive	1	3.03	Bright	1 3.03
	Blue	Colour Combination	3	9.09	<u>Masculine</u>	<u>1</u> <u>3.03</u>
		<u>Clam</u>	<u>2</u>	<u>6.06</u>	<u>Nature</u>	<u>1</u> <u>3.03</u>
		<u>Low Profile</u>	<u>1</u>	<u>3.03</u>	<u>Official</u>	<u>1</u> <u>3.03</u>
	Purple	Clam	2	6.06	Highlight	1 3.03
		Colour Contrast	2	6.06	Low Profile	1 3.03
Tool Kit	Familiar		2	5.41		
	Orange	<u>Skin</u>	<u>2</u>	<u>5.41</u>	Herbal	1 2.70
		<u>Clam</u>	<u>1</u>	<u>2.70</u>	<u>Nature</u>	<u>1</u> <u>2.70</u>
		Health	1	2.70	Papaya	1 2.70
	Yellow	Less Artificial Colour	4	10.81	Health	1 2.70
		<u>Bright</u>	<u>1</u>	<u>2.70</u>	<u>Lemon</u>	<u>1</u> <u>2.70</u>
		<u>Cool</u>	<u>1</u>	<u>2.70</u>	Nature	1 2.70
		<u>Fresh</u>	<u>1</u>	<u>2.70</u>		
Tool Kit	Green	Apple	1	2.70	Fresh	1 2.70
	Blue	<u>Cleanness</u>	<u>5</u>	<u>13.51</u>	Mint	1 2.70
		<u>Fresh</u>	<u>4</u>	<u>10.81</u>	<u>Nature</u>	<u>1</u> <u>2.70</u>
		<u>Cool</u>	<u>3</u>	<u>8.11</u>	Personal-Care	1 2.70
	Purple	Special	1	2.70		
	Colour preference		14	41.18		
	Familiar		5	14.71		
	Red	<u>Alarm</u>	<u>2</u>	<u>5.88</u>	Kitchen	1 2.94
		Outstanding	2	5.88	Noticeable	1 2.94
		Colour Combination	1	2.94		

	Orange	Colour Combination	1	2.94	Outstanding	1	2.94
	Green	Noticeable	1	2.94			
	Blue	Clam	2	5.88	Safty	1	2.94
		Colour Contrast	1	2.94			
	Purple	decoration	1	2.94			
Toothpaste	Colour preference		3	6.98			
	Familiar		4	9.30			
	Yellow	Lemon	1	2.33			
	Green	Clean	1	2.33	Mint	1	2.33
		Fresh	1	2.33			
	Blue	Clean	14	32.56	Cool	1	2.33
		Medical	6	13.95	Natural	1	2.33
		Fresh	2	4.65	Professional	1	2.33
		Health	2	4.65	Teeth	1	2.33
		Mint	2	4.65	Whitening	1	2.33
	Purple	Clean	1	2.33			
Trousers	Colour preference		15	46.88			
	Red	Sport	1	3.13			
	Orange	Sport	2	6.25	Vivo	1	3.13
	Blue	Colour Combination	4	12.50	Normal	1	3.13
		Dark	3	9.38	Sober	1	3.13
		Against Dirty	1	3.13	Sport	1	3.13
		Comfortable	1	3.13			
	Purple	Colour Combination	1	3.13			
T-Shirt	Colour preference		18	50.00			
	Red	Sport	2	5.56	Energetic	1	2.78
		Brave	1	2.78	Noticeable	1	2.78
		Bright	1	2.78	Passion	1	2.78
		Colour Combination	1	2.78			
	Orange	Colour Combination	1	2.78	Normal	1	2.78
		Energetic	1	2.78	Young	1	2.78
	Yellow	Bright	1	2.78			
	Green	Clean	1	2.78			
	Blue	Against Dirty	1	2.78	Dark	1	2.78
		Colour Combination	1	2.78			
	Purple	Noticeable	1	2.78			
USB	Colour preference		17	44.74			
	Red	Noticeable	7	18.42			
	Orange	Bright	1	2.63	Special	1	2.63
	Yellow	Colour Contrast	1	2.63	Noticeable	3	7.89
	Green	Bright	1	2.63	Distinctive	1	2.63
	Blue	Safty	2	5.26	Steady	1	2.63
		Official	1	2.63			
	Purple	Decoration	1	2.63	Noticeable	1	2.63
Vase	Colour preference		7	17.50			
	Red	Colour Combination	2	5.00	Decoration	1	2.50
		Bright	1	2.50			

	Orange	Colour Combination	1	2.50	<u>Warm</u>	<u>1</u>	<u>2.50</u>
		Gentle	1	2.50			
	Yellow	Colour Combination	6	15.00	Light	1	2.50
		Decoration	1	2.50	Vivo	1	2.50
		<u>Fresh</u>	<u>1</u>	<u>2.50</u>			
	Green	<u>Plants</u>	<u>1</u>	<u>2.50</u>			
	Blue	Colour Combination	7	17.50	Decoration	1	2.50
		Elegant	2	5.00	Simple	1	2.50
	Purple	Colour Combination	2	5.00	Distinctive	1	2.50
		Decoration	1	2.50			
Washing Up Liquid	Familiar		5	12.50			
	Red	<u>Strawberry</u>	<u>3</u>	<u>7.50</u>	<u>Cranberry</u>	<u>1</u>	<u>2.50</u>
		<u>Cherry</u>	<u>1</u>	<u>2.50</u>			
	Orange	<u>Orange</u>	<u>1</u>	<u>2.50</u>			
	Yellow	<u>Lemon</u>	<u>6</u>	<u>15.00</u>	Cleanness	1	2.50
		Less Artificial Colour	1	2.50			
	Green	Apple	7	17.50	Health	1	2.50
		Lemon	3	7.50	Lime	1	2.50
		Cleanness	2	5.00	<u>Mint</u>	<u>1</u>	<u>2.50</u>
		<u>Fresh</u>	<u>2</u>	<u>5.00</u>			
	Blue	<u>Cleanness</u>	<u>3</u>	<u>7.50</u>			
	Purple	Special	1	2.50			
Yogurt	Colour preference		2	7.14			
	Familiar		1	3.57			
	Red	<u>Strawberry</u>	<u>13</u>	<u>46.43</u>	Raspberry	1	3.57
	Orange	Happy	1	3.57			
	Yellow	<u>Lemon</u>	<u>4</u>	<u>14.29</u>	Vanilla	1	3.57
		<u>Fruits</u>	<u>1</u>	<u>3.57</u>	White	1	3.57
		Nature	1	3.57			
	Purple	<u>Blueberry</u>	<u>1</u>	<u>3.57</u>	<u>Grape</u>	<u>1</u>	<u>3.57</u>

Appendix E

E.1 Experimental samples procedure for Study III (20 products, the table is two pages long).

Product name	Red	Orange	Yellow	Green	Blue	Purple
Calculator						
Candy						
Cheese						
Cream						
Dental Floss						
Deodorant						
Hand Cream						
Hand Wash Gel						

Ice Cream						
Laundry Detergent						
Makeup-Remover						
Milk						
Shave Splash						
Soap Bar						
Table Cleaner						
Toner						
Toothpaste						
Vase						
Washing Up Liquid						
Yogurt						

E.2 Information Sheet Form (Study III).

Information Sheet

Research title: Consumers' purchasing behaviour of the product-colour decision in different time-length conditions.

'You are being invited to take part in a research project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.'

What is the purpose of the project?

The aims are following: 1) to test whether the length of shopping time affects the stability of consumers' product colour decisions; 2) to identify the relationship between colour preference and the length of shopping time in consumers' product colour decisions; 3) to explore the relationship between the two research methods (multiple choice for 6-alternative forced-choice and multiple choice for rank-order) for colour preference research.

Why have I been chosen?

Anyone age above 18 with a normal colour vision can take part in this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form and you can still withdraw at any time without it affecting any benefits that you are entitled to in any way. You do not have to give a reason.

What do I have to do?

Two research activities (two laboratory experiment) will carry out in a laboratory to ascertain the colour that participants would prefer to buy for each product. In timing control laboratory experiment, you will be asked to indicate the colour for each product within four seconds. At the end of each experiment, you will be asked to give an order for your colour preference (six colours). To ensure that you forget the product categories and answers for the time-control laboratory experiment, you will be requested to finish the non-time-control laboratory experiment two to three weeks after you finish the first one.

Other things you might like to know.

The participant will be given a copy of the information sheet. For further information please contact Luwen Yu on ml14l2y@leeds.ac.uk. Thank you for taking the time to read through the information.

E.3 Information Consent Form (Study III).

Consent to take part in [Consumers' purchasing behaviour of the product- colour decision in different time- length conditions]

Add your initials
next to the
statement if you
agree

• I confirm that I have read and understand the information sheet dated [insert date] explaining the above research project.	
• I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question(s), I am free to decline.	
• I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report(s) that result from the research.	
• I agree for the data collected from me to be stored and used in relevant future research in an anonymised form.	
• I understand that other genuine researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.	
• I understand that other genuine researchers may use my words in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.	

I understand that relevant sections of the data collected during the study, may be looked at by individuals from the University of Leeds or from regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.	
I agree to take part in the above research project and will inform the lead researcher should my contact details change.	

Name of participant:

Name of researcher: Luwen Yu

Researcher's signature:

Participant's signature:

Yu Luwen .

Date:

Date: / /

2016

Appendix F

F.1 Frequencies of key words from colour associations from male (The table is two pages long).

Colour Name	Word (Association)	Count	Weighted (%)	Word (Association)	Count	Weighted (%)
Red	Culture	8	19.0	Football	1	2.4
	China	3	7.1	Happy	1	2.4
	National Flag	3	7.1	High-profile	1	2.4
	Passion	3	7.1	Love	1	2.4
	Abrupt	1	2.4	Marriage	1	2.4
	Africa	1	2.4	Medical	1	2.4
	Attractive	1	2.4	Hot-pot	1	2.4
	Barbecue	1	2.4	Sports	1	2.4
	Blood	1	2.4	Summer	1	2.4
	Bright	1	2.4	Tomato	1	2.4
	Evil	1	2.4	Unrestrained	1	2.4
	Excitement	1	2.4	Vibrant	1	2.4
	Exercise	1	2.4	Vitality	1	2.4
	Festival	1	2.4	Vivo	1	2.4
	Fire	1	2.4			
Orange	Oranges	7	29.2	Eyeful	1	4.2
	Warm	4	16.7	Fireman	1	4.2
	Hat	2	8.3	Fruit	1	4.2
	Moderate	2	8.3	Nature	1	4.2
	Comfortable	1	4.2	Vibrant	1	4.2
	Disgusting	1	4.2	Wood	1	4.2
	Food	1	4.2			
Yellow	Bright	3	11.5	Gold	1	3.8
	Lemon	3	11.5	High Profile	1	3.8
	Sun	3	11.5	Iconic	1	3.8
	Catching Eyes	2	7.7	Lively	1	3.8
	Warning	2	7.7	Morning	1	3.8
	Active	1	3.8	Negative	1	3.8
	Banana	1	3.8	Uncomfortable	1	3.8
	Candle	1	3.8	Warm	1	3.8
	Food	1	3.8	Attention	1	3.8
Green	Fresh	4	13.3	Fluorescent	1	3.3
	Grass	3	10.0	Freshness	1	3.3
	Cool	2	6.7	Hope	1	3.3
	Forest	2	6.7	Leaves	1	3.3
	Nature	2	6.7	Natural	1	3.3
	Positive	2	6.7	Protection	1	3.3
	Trees	2	6.7	Quiet	1	3.3
	Comfortable	1	3.3	Ready	1	3.3
	Dazzling	1	3.3	Sunshine	1	3.3
	Environmental Friendly	1	3.3	Traffic Light	1	3.3

Blue	Sky	7	17.1	Boyish	1	2.4
	Comfortable	4	9.8	Cooling	1	2.4
	Calm	3	7.3	Efficient	1	2.4
	Jeans	3	7.3	Lake	1	2.4
	Low-key	3	7.3	Ocean	1	2.4
	Sea	3	7.3	Official	1	2.4
	Cool	2	4.9	Public	1	2.4
	Deep	2	4.9	Trust	1	2.4
	Cleanness	2	4.9	Vast	1	2.4
	Fresh	2	4.9	Water	1	2.4
Purple	Lavender	3	15.8	Mysterious	1	5.3
	Elegant	2	10.5	Peaceful	1	5.3
	High Quality	2	10.5	Plants	1	5.3
	Coquettish	1	5.3	Positive	1	5.3
	Friendless	1	5.3	Psychedelic	1	5.3
	Grapes	1	5.3	Sensitive	1	5.3
	Happy	1	5.3	Sky	1	5.3
	Magic	1	5.3			

F.2 Frequencies of key words from colour associations from female (The table is two pages long).

Colour Name	Word (Association)	Count	Weighted (%)	Word (Association)	Count	Weighted (%)
Red	Culture	11	16.2	Cranberry	1	1.5
	Passion	6	8.8	Energy	1	1.5
	Warm	5	7.4	Lipstick	1	1.5
	China	4	5.9	Luck	1	1.5
	National Flag	4	5.9	Meat	1	1.5
	Strawberry	4	5.9	Mood	1	1.5
	Fire	4	5.9	Positive	1	1.5
	Blood	3	4.4	Publicity	1	1.5
	New Year	3	4.4	Rich	1	1.5
	Bright	3	4.4	Ripe Fruit	1	1.5
	Cheerful	2	2.9	Rose	1	1.5
	Sun	2	2.9	Signal	1	1.5
	Alarm	1	1.5	Watermelon	1	1.5
	Brave	1	1.5	Motivation	1	1.5
	Cherry	1	1.5			
Orange	Oranges	11	30.6	Hot	1	2.8
	Warm	4	11.1	Leather	1	2.8
	Sun	4	11.1	Peaches	1	2.8
	Comfortable	3	8.3	Soft	1	2.8
	Skin	2	5.6	Vitality	1	2.8
	Calm	1	2.8	Young	1	2.8
	Camel	1	2.8	Bright	1	2.8
	Cortex	1	2.8	Vivo	1	2.8
	Hermes	1	2.8			
Yellow	Lemon	7	17.1	Elegant	1	2.4
	Bright	4	9.8	Fluorescent	1	2.4
	Banana	3	7.3	High profile	1	2.4
	Fresh	3	7.3	Passionate	1	2.4
	Warm	3	7.3	Pure	1	2.4
	Cool	2	4.9	Sour	1	2.4
	Happy	2	4.9	Sunflower	1	2.4
	Sun	2	4.9	Vibrant	1	2.4
	Clean	2	4.9	Wheat	1	2.4
	Butter	1	2.4	Attractive	1	2.4
	Cheese	1	2.4	Vivo	1	2.4
Green	Grass	5	16.1	Directly	1	3.2
	Fresh	3	9.7	Environmental Friendly	1	3.2
	Nature	3	9.7	Grassland	1	3.2
	Plants	3	9.7	Lawn	1	3.2
	Leaves	2	6.5	Mint	1	3.2
	Vegetables	2	6.5	Practical	1	3.2
	Bright	1	3.2	Protection	1	3.2
	Clam	1	3.2	Spring	1	3.2
	Cool	1	3.2	Tree	1	3.2
	Coquettish	1	3.2			
Blue	Calm	8	19.5	Jeans	1	2.4

	Fresh	7	17.1	Lofty	1	2.4
	Sea	4	9.8	Melancholy	1	2.4
	Sky	4	9.8	Minded	1	2.4
	Rational	2	4.9	Nature	1	2.4
	Water	2	4.9	Original	1	2.4
	Men/Boyish	2	4.9	Out-space	1	2.4
	Broad	1	2.4	Sportswear	1	2.4
	Expensive	1	2.4	Cleanness	1	2.4
	Fashion	1	2.4			
Purple	Lavender	5	19.2	Elegant	1	3.8
	Gentle	2	7.7	Feminine	1	3.8
	Grapes	2	7.7	Romantic	1	3.8
	High Quality	2	7.7	Sex	1	3.8
	Mysterious	2	7.7	Violet	1	3.8
	Aristocracy	1	3.8	Womanliness	1	3.8
	Carpet	1	3.8	Blueberry	1	3.8
	Decoration	1	3.8	Sleeping	1	3.8
	Dream	1	3.8	Comfortable	1	3.8

F.3 Frequencies of key words from product-colour choosing reasons from male (The table is two pages long).

Colour Name	Word (Association)	Count	Weighted (%)	Word (Association)	Count	Weighted (%)
Red	Strawberry	21	12.8	Cheerful	1	0.6
	Noticeable	17	10.4	Cherry	1	0.6
	Warm	13	7.9	Chill	1	0.6
	Fire	11	6.7	Chinese	1	0.6
	Bright	8	4.9	Christmas	1	0.6
	Colour Combination	7	4.3	Colour harmony	1	0.6
	Luck	7	4.3	Comfortable	1	0.6
	Decoration	5	3.0	Durable	1	0.6
	Alarm	4	2.4	Easy	1	0.6
	Coffee Bean	4	2.4	Exciting	1	0.6
	Passion	4	2.4	Formal	1	0.6
	Energetic	3	1.8	Fruits	1	0.6
	Happy	3	1.8	High Quality	1	0.6
	Heat	3	1.8	Loudness	1	0.6
	Hot	3	1.8	Lovely	1	0.6
	Raspberry	3	1.8	Morning	1	0.6
	Refresh	3	1.8	New Year	1	0.6
	Tense	3	1.8	Power	1	0.6
	Anti-bacteria	2	1.2	Semantic	1	0.6
	Dark	2	1.2	Sober	1	0.6
	Degerming	2	1.2	Special	1	0.6
	Distinctive	2	1.2	Stimulate	1	0.6
	Enjoy	2	1.2	Sweet	1	0.6
	Outstanding	2	1.2	Tasty	1	0.6
	Safe	2	1.2	Technology	1	0.6
	Attractive	1	0.6	Vital	1	0.6
	Brave	1	0.6			
Orange	Oranges	7	9.7	Cleanness	1	1.4
	Warm	7	9.7	Decoration	1	1.4
	Colour Combination	4	5.6	Degerming	1	1.4
	Coffee Bean	3	4.2	Energy	1	1.4
	Bright	3	4.2	Happy	1	1.4
	Comfortable	3	4.2	Colour harmony	1	1.4
	Dirty	3	4.2	Health	1	1.4
	Dark	2	2.8	High-quality	1	1.4
	Noticeable	2	2.8	Leather	1	1.4
	Skin	2	2.8	Light	1	1.4
	Strawberry	2	2.8	Milk	1	1.4
	Sweet	2	2.8	Nature	1	1.4
	Distinctive	2	2.8	Passion	1	1.4
	Anti-bacteria	1	1.4	Relaxing	1	1.4
	Less-artificial	1	1.4	Semantic	1	1.4
	Brown	1	1.4	Special	1	1.4
	Cheerful	1	1.4			

Yellow	Cheese	12	31.6	Fire	1	2.6
	Cream	3	7.9	Fruits	1	2.6
	Health	3	7.9	Morning	1	2.6
	Milk	3	7.9	Music	1	2.6
	Non-artificial	2	5.3	Nature	1	2.6
	Egg	2	5.3	Noticeable	1	2.6
	Fresh	2	5.3	Refresh	1	2.6
	Lemon	2	5.3	Sun	1	2.6
	Bright	1	2.6			
Green	Fresh	29	43.9	Attractive	1	1.5
	Noticeable	5	7.6	Energetic	1	1.5
	Apple	4	6.1	Fruits	1	1.5
	Cool	4	6.1	Grass	1	1.5
	Bright	3	4.5	Health	1	1.5
	Distinctive	3	4.5	Lemon	1	1.5
	Eco-friendly	2	3.0	Plants	1	1.5
	Mint	2	3.0	Semantic	1	1.5
	Nature	2	3.0	Skimmed	1	1.5
	Safe	2	3.0	Vegetable	1	1.5
Blue	Cleanness	50	25.8	Decoration	2	1.0
	Cool	21	10.8	Nature	2	1.0
	Dirty	17	8.7	Ocean	2	1.0
	Fresh	15	7.7	Read	2	1.0
	Colour Combination	13	6.7	Dark	1	0.5
	Low-key	8	4.1	Eco-friendly	1	0.5
	Masculine	7	3.6	Effective	1	0.5
	Mint	7	3.6	Elegant	1	0.5
	Hygiene	6	3.1	Fruits	1	0.5
	Personal Care	5	2.6	Highlight	1	0.5
	Serious	5	2.6	Noticeable	1	0.5
	Clam	5	1.5	Peaceful	1	0.5
	Ink	3	1.5	Safety	1	0.5
	Medical	3	1.5	Sky	1	0.5
	Official	3	1.5	Swimming	1	0.5
	Business	2	1.0	Tooth	1	0.5
	Comfortable	2	1.0	Warm	1	0.5
	Colour contrast	2	1.0	Winter	1	0.5
Purple	Colour Combination	3	13.0	High-profile	1	4.3
	Decoration	3	13.0	Interesting	1	4.3
	Warm	3	13.0	Lavender	1	4.3
	Comfortable	2	8.7	Low-quality	1	4.3
	Nature	2	8.7	Special	1	4.3
	Clam	1	4.3	Sweet	1	4.3
	Cool	1	4.3	Fruits	1	4.3
	Elegance	1	4.3			

F.4 Frequencies of key words from product-colour choosing reasons from female (The table is two pages long).

Colour Name	Word (Association)	Count	Weighted (%)	Word (Association)	Count	Weighted (%)
Red	Noticeable	16	10.7	Colour contrast	2	1.3
	Strawberry	14	9.3	Kitchen	2	1.3
	Warm	14	9.3	Sexy	2	1.3
	Colour Combination	11	7.3	Sweet	2	1.3
	Passion	9	6.0	Watermelon	2	1.3
	Fire	8	5.3	Tempera	2	1.3
	Chocolate	6	4.0	Careless	1	0.7
	Bright	6	4.0	China	1	0.7
	Decoration	4	2.7	Christmas	1	0.7
	Exciting	4	2.7	Clam	1	0.7
	Heat	4	2.7	Dark	1	0.7
	Attractive	4	2.7	Drink	1	0.7
	Alarm	3	2.0	Home	1	0.7
	Bean	3	2.0	Personalized	1	0.7
	Brave	3	2.0	Pomegranate	1	0.7
	Cranberry	3	2.0	Preciseness	1	0.7
	High Quality	3	2.0	Professional	1	0.7
	Motivation	3	2.0	Refresh	1	0.7
	Sporty	3	2.0	Reliable	1	0.7
	Luck	3	2.0	Rigorous	1	0.7
Orange	Oranges	19	19.8	Cute	1	1.0
	Warm	17	17.7	Decoration	1	1.0
	Soft	5	5.2	Energetic	1	1.0
	Noticeable	4	4.2	Feminine	1	1.0
	Coffee Bean	3	3.1	Fun	1	1.0
	Colour Combination	3	3.1	Colour Harmony	1	1.0
	Papaya	3	3.1	Health	1	1.0
	Sporty	3	3.1	Herbal	1	1.0
	Bright	3	3.1	Low Key	1	1.0
	Comfortable	2	2.1	Natural	1	1.0
	Dirty	2	2.1	Normal	1	1.0
	Highlight	2	2.1	Passion	1	1.0
	Leather	2	2.1	Peach	1	1.0
	Skin	2	2.1	High Quality	1	1.0
	Fire	2	2.1	Sunshine	1	1.0
	Cleanness	2	2.1	Sweet	1	1.0
	Active	1	1.0	Young	1	1.0
	Calm	1	1.0	Comfortable	1	1.0
	Colourful	1	1.0	Vivo	1	1.0
Yellow	Cheese	14	31.1	Cleanness	1	2.2
	Milk	5	11.1	Colour Combination	1	2.2
	Bright	3	6.7	Cream	1	2.2
	Egg	3	6.7	Cute	1	2.2

	Lemon	3	6.7	Dairy	1	2.2
	Non-artificial	2	4.4	Durable	1	2.2
	Food	2	4.4	Fruit	1	2.2
	Health	2	4.4	Gentle	1	2.2
	Strong	2	4.4	Safe	1	2.2
Green	Fresh	12	21.4	Tea	2	3.6
	Bright	7	12.5	Alarm	1	1.8
	Cleanness	6	10.7	Anti-bacteria	1	1.8
	Apple	5	8.9	Energetic	1	1.8
	Lime/Lemon	4	7.1	Farm	1	1.8
	Noticeable	3	5.4	Fun	1	1.8
	Cool	2	3.6	Organic	1	1.8
	Mint	2	3.6	Degerming	1	1.8
	Natural	2	3.6	Eco-friendly	1	1.8
	Safe	2	3.6	Green Apple	1	1.8
Blue	Cleanness	70	32.4	Elegant	1	0.5
	Masculine	18	8.3	Fruit	1	0.5
	Colour Combination	12	5.6	Hospital	1	0.5
	Cool	11	5.1	Hygiene	1	0.5
	Dark	11	5.1	Low Key	1	0.5
	Dirty	11	5.1	Whole Milk	1	0.5
	Safety	9	4.2	Moisturizing	1	0.5
	Clam	9	4.2	Normal	1	0.5
	Nature	6	2.8	Noticeable	1	0.5
	Medical	5	2.3	Official	1	0.5
	Mint	5	2.3	Oral	1	0.5
	Health	4	1.9	Peaceful	1	0.5
	Academic	2	0.9	Professional	1	0.5
	Less-artificial	2	0.9	Relax	1	0.5
	Highlight	2	0.9	Reliable	1	0.5
	Ink	2	0.9	Science	1	0.5
	Strong	2	0.9	Serious	1	0.5
	Water	2	0.9	Simple	1	0.5
	Original	2	0.9	Soft	1	0.5
	Tooth	2	0.9	Stable	1	0.5
	Comfortable	1	0.5	Technology	1	0.5
	Concentrate	1	0.5	Whitening	1	0.5
	Decoration	1	0.5	Work	1	0.5
	Dentistry	1	0.5	Temperam	1	0.5
Purple	Lavender	10	27.8	Attractive	2	5.6
	Decoration	8	22.2	Birthday	1	2.8
	Romantic	3	8.3	Against Dirty	1	2.8
	Blueberry	2	5.6	Peaceful	1	2.8
	Colour Combination	2	5.6	Decoration	1	2.8
	Fancy	2	5.6	Temperam	1	2.8
	Grape	2	5.6			

Publication List

Publications related to this thesis:

Yu, L., Westland, S., Li, Z., Pan, Q., Shin, M. J., & Won, S. (2018). The role of individual colour preferences in consumer purchase decisions. *Color Research & Application*, 43(2), 258-267.

Yu, L., Westland, S., Chen, Y., & Li, Z. (2021). Colour associations and consumer product-colour purchase decisions. *Color Research & Application*, 2021;1–9.

Yu, L., Westland, S., Li, Z. & Xia, G. (2021). The effect of decision time-length condition on consumer product-colour purchase decision. *Color Research & Application*, 2021;1–11.

Yu, L., Westland, S., & Li, Z. (2021). Analysis of experiments to determine individual colour preference. *Color Research & Application*, 46(1), 155-167.

Luwen Yu, Stephen Westland and Zhenghong Li (2017), "Gender and Cultural Effects on Consumer Colour-Purchase Decisions," in 2017, 13th AIC (Association Internationale de la Couleur) International Congress.

Publication connected to this thesis:

Luo, D., Yu, L., Westland, S., & Mahon, N. (2019). The influence of colour and image on consumer purchase intentions of convenience food. *Journal of the International Colour Association*, 24, 11-23.